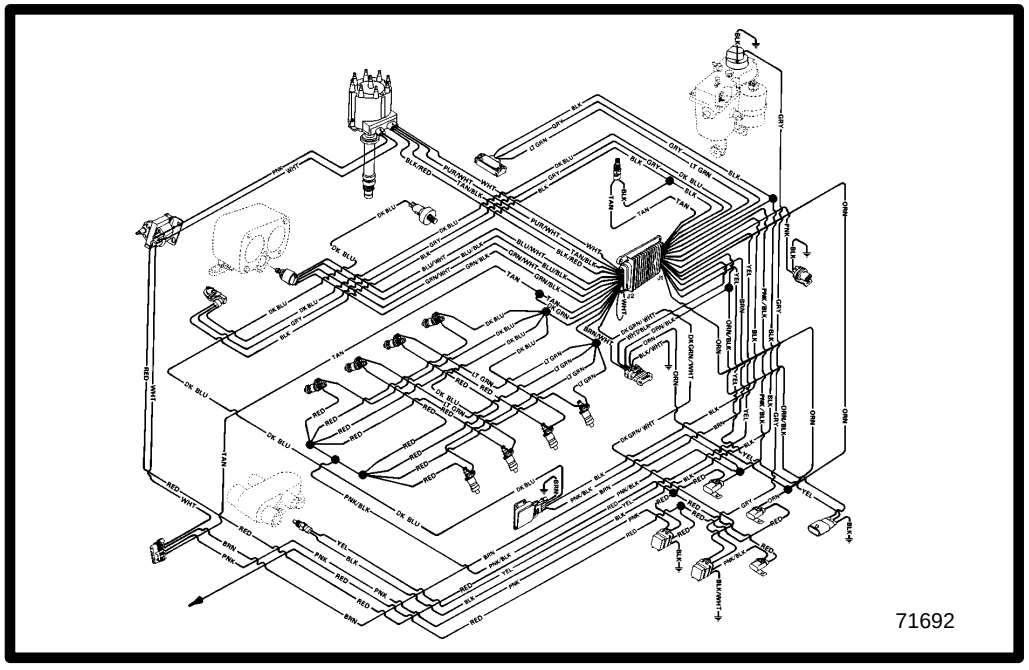
FUEL SYSTEMS



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MULTI-PORT AND THROTTLE BODY FUEL INJECTION

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General Information

⚠ CAUTION

To reduce the chance of personal injury and/or property damage, the following instructions must be carefully observed: proper service and repair are important to the safety of the service technician and the safe, reliable operation of all MerCruiser Electronic Fuel Injection (Multi-Port And Throttle Body) equipped engines. If part replacement is necessary, the part must be replaced with one of the same part number or with an equivalent part. Do not use a replacement part of lesser quality. The service procedures recommended and described in this service manual are effective methods of performing service and repair. Some of these procedures require the use of tools specially designed for the purpose. Accordingly, anyone who intends to use a replacement part, service procedure or tool, which is not recommended by the system manufacturer, must first determine that neither his safety nor the safe operation of the engine will be jeopardized by the replacement part, service procedure or tool selected. It is important to note that this manual contains various "Cautions" and "Notes" that must be carefully observed in order to reduce the risk of personal injury during service or repair, or the possibility that improper service or repair may damage the engine or render it unsafe. It is also important to understand that these "Cautions" and "Notes" are not exhaustive, because it is impossible to warn of all the possible hazardous consequences that might result from failure to follow these instructions.

Introduction

The following manual has been prepared for effective diagnosis of the MerCruiser Electronic Fuel Injection system.

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication approval. The right is reserved to make changes at any time without notice.

An understanding of the material contained herein and in subsequent publications issued when necessary, will assist service personnel in properly maintaining the quality to which MerCruiser engine control systems are built.

Visual/Physical Inspection

A careful visual and physical inspection must be performed as part of any diagnostic procedure. This can often lead to fixing a problem without further steps. Inspect all vacuum hoses for correct routing, pinches, cuts, or disconnects. Be sure to inspect hoses that are difficult to see. Inspect all the wires in the engine compartment for proper connections, burned or chafed spots, pinched wires, or contact with sharp edges or hot exhaust manifolds. This visual/physical inspection is very important. It must be done carefully and thoroughly.

Basic Knowledge and Tools Required

To use this manual most effectively, a general understanding of basic electrical circuits and circuit testing tools is required. You should be familiar with wiring diagrams; the meaning of volts, ohms and amperes; the basic theories of electricity; and understand what happens in an open or shorted wire. To perform system diagnosis, several special tools and equipment are required. Please become acquainted with the tools and their use before attempting to diagnose the system. Special tools which are required for system service are listed later in this section (see "Table of Contents").

Electrostatic Discharge Damage

Electronic components used in control systems are often designed to carry very low voltage, and are very susceptible to damage caused by electrostatic discharge. It is possible for less than 100 volts of static electricity to cause damage to some electronic components. By comparison, it takes 4,000 volts for a person to even feel the effect of a static discharge.

There are several ways for a person to become statically charged. The most common methods of charging are by friction and by induction. An example of charging by friction is a person sliding across a seat, in which a charge of as much as 25,000 volts can build up. Charging by induction occurs when a person with well-insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off, leaving the person highly charged with the opposite polarity. Static charges of either type can cause damage; therefore, it is important to use care when handling and testing electronic components.

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Diagnostic Information

The diagnostic charts and functional checks in this manual are designed to locate a faulty circuit or component through logic based on the process of elimination. **The charts are prepared with the requirement that the system functioned correctly at the time of assembly and that there are no multiple failures.**

Wiring Harness Service

Marine engine control circuits contain many special design features not found in standard land vehicle wiring. Environmental protection is used extensively to protect electrical contacts and proper splicing methods must be used when necessary.

The proper operation of low amperage input/output circuits depends upon good continuity between circuit connectors. It is important before component replacement and/or during normal troubleshooting procedures that a visual inspection of any questionable mating connector is performed. Mating surfaces should be properly formed, clean and likely to make proper contact. Some typical causes of connector problems are listed below.

1. Improperly formed contacts and/or connector housing.
2. Damaged contacts or housing due to improper engagement.
3. Corrosion, sealer or other contaminants on the contact mating surfaces.
4. Incomplete mating of the connector halves during initial assembly or during subsequent troubleshooting procedures.
5. Tendency for connectors to come apart due to vibration and/or temperature cycling.
6. Terminals not fully seated in the connector body.
7. Inadequate terminal crimps to the wire.

Wire harnesses should be replaced with proper part number harnesses. When signal wires are spliced into a harness, use the same gauge wire with high temperature insulation only.

With the low current and voltage levels found in the system, it is important that the best possible bond be made at all wire splices by soldering the splices, as shown in the following illustrations. Use care when probing a connector or replacing connector terminals. It is possible to short between opposite terminals. If this happens, certain components can be damaged. Always use jumper wires with the corresponding mating terminals between connectors for circuit checking. **NEVER** probe through connector seals, wire insulation, secondary ignition wires, boots, nipples or covers.

Microscopic damage or holes will result in eventual water intrusion, corrosion and/or component or circuit failure.

WIRE REPAIR

1. Locate damaged wire.
2. Remove insulation as required.

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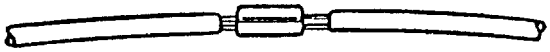
3. Splice two wires together using splice clips and rosin core solder.



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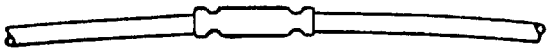
4. Cover splice with heat shrink sleeve to insulate from other wires.



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Wiring Connector Service

Most connectors in the engine compartment are protected against moisture and dirt which could create oxidation and deposits on the terminals. This protection is important because of the very low voltage and current levels found in the electronic system. The connectors have a lock which secures the male and female terminals together. A secondary lock holds the seal and terminal into the connector.

When diagnosing, open circuits are often difficult to locate by sight because oxidation or terminal misalignment are hidden by the connectors. Merely wiggling a connector on a sensor or in the wiring harness may locate the open circuit condition. This should always be considered when an open circuit or failed sensor is indicated. Intermittent problems may also be caused by oxidized or loose connections.

Before making a connector repair, be certain of the type of connector. Some connectors look similar but are serviced differently. Replacement connectors and terminals are listed in the Parts Catalog.

Ensure that the connector seals are not deformed or crushed when mating the connectors together.

Abbreviations

BARO	Barometric Pressure
BAT	Battery Positive Terminal, Battery or System Voltage
B+	Battery Positive
CKT	Circuit
CONN	Connector
CYL	Cylinder
DEG	Degrees
DIAG	Diagnostic
DIST	Distributor
DLC	Data Link Connector
DTC	Diagnostic Trouble Code
DVOM	Digital Volt Ohm Meter
ECM	Engine Control Module
ECT	Engine Coolant Temperature
EEPROM	Electronic Erasable Programmable Read Only Memory
HEI	High Energy Ignition
EMI	Electromagnetic Interference
ENG	Engine
GND	Ground
GPH	Gallons Per Hour
IAC	Idle Air Control
IAT	Intake Air Temperature
IC	Ignition Control

IGN	Ignition
INJ	Injection
kPa	Kilopascal
KS	Knock Sensor System
KV	Kilovolts
MAP	Manifold Absolute Pressure
MIL	Malfunction Indicator Lamp
mSec	Millisecond
N/C	Normally Closed
N/O	Normally Open
PROM	Programmable Read Only Memory
RAM	Random Access Memory
REF HI	Reference High
REF LO	Reference Low
ROM	Read Only Memory
SLV	Slave
SW	Switch
TACH	Tachometer
TERM	Terminal
TP	Throttle Position
V	Volts
VAC	Vacuum
WOT	Wide Open Throttle
in-hg	Inches Of Mercury

Changes In Terminology

Due to industry standardization of terminology for certain electronic engine controls some names and abbreviations have changed.

From	To
(CTS) Coolant Temperature Sensor	(ECT) Engine Coolant Temperature
(TPS) Throttle Position Sensor	(TP) Throttle Position
(MAT) Manifold Air Temperature	(IAT) Intake Air Temperature
(EST) Electronic Spark Timing	(IC) Ignition Control
(ESC) Electronic Spark Control	(KS) Knock Sensor
(ALDL) Assembly Line Data Link	(DLC) Data Link Connector

Diagnostic Trouble Codes

Code Number	Code Description
Code 12	Ignition On - Engine Not Running
Code 14	(ECT) Engine Coolant Temperature
Code 21	(TP) Throttle Position Sensor
Code 23	(IAT) Intake Air Temperature
Code 33	(MAP) Manifold Absolute Pressure
Code 42	(IC) Ignition Control
Code 43	(KS) Knock Sensor
Code 51	Calibration Memory Failure

ECM Self-Diagnostics

The ECM performs a continual self-diagnosis on certain control functions. This diagnostic capability is complemented by the diagnostic procedures contained in this manual. The ECM's language for communicating the source of a malfunction is a system of diagnostic codes. The codes are two digit numbers that can range from 12 to 51. When a malfunction is detected by the ECM, a code is set and the Malfunction Indicator Lamp is illuminated.

Diagnostic Code Tool With Malfunction Indicator Lamp

There are various manufacturers of Diagnostic Code Tools. Most Tools are equipped with a Malfunction Indicator Lamp (MIL).

- It informs the service technician that a problem has occurred and that the vessel is in need of service as soon as reasonably possible.
- It displays Codes stored by the ECM which help the technician diagnose system problems.

As a bulb and system check, the lamp will come ON with the key on and the engine not running. When the engine is started, the light will turn OFF. If the lamp remains ON, the self-diagnostic system has detected a problem. If the problem goes away, the light will go out in most cases after ten seconds, but a code will remain stored in the ECM.

When the lamp remains ON while the engine is running, or when a malfunction is suspected due to a driveability problem, "EFI Diagnostic Circuit Check" must be performed. These checks will expose malfunctions which may not be detected if other diagnostics are performed prematurely.

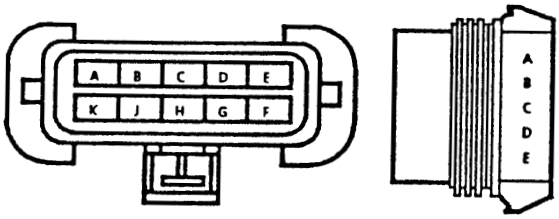
Intermittent Malfunction Indicator Lamp

In the case of an intermittent problem, the Malfunction Indicator Lamp will light for ten seconds and then will go out. However, the corresponding code will be stored in the memory of the ECM. When unexpected codes appear during the code reading process, one can assume that these codes were set by an intermittent malfunction and could be helpful in diagnosing the system.

An intermittent code may or may not reset. IF IT IS AN INTERMITTENT FAILURE, A DIAGNOSTIC CODE CHART IS NOT USED. Consult the "Diagnostic Aids" on the same page as the diagnostic code chart. "Troubleshooting" also covers the topic of "Intermittents." A physical inspection of the applicable sub-system most often will resolve the problem.

Reading Codes

The provision for communicating with the ECM is the Data Link Connector (DLC) connector. It is part of the EFI engine wiring harness, and is a 10-pin connector, which is electrically connected to the ECM. It is used in the assembly plant to receive information in checking that the engine is operating properly before it leaves the plant. The code(s) stored in the ECM's memory can be read either through a scan tool, (a diagnostic scanner that plugs into the DLC connector), or by counting the number of flashes of the Malfunction Indicator Lamp when the diagnostic code tool is installed and SERVICE mode is selected.



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DLC Connector

Once the diagnostic code tool has been connected, the ignition switch must be moved to the ON position, with the engine not running. At this point, the Malfunction Indicator Lamp should flash Code 12 three times consecutively. This would be the following flash sequence: flash, pause, flash-flash, long pause, flash, pause, flash-flash, long pause, flash, pause, flash-flash. Code 12 indicates that the ECM's diagnostic system is operating. If Code 12 is not indicated, a problem is present within the diagnostic system itself, and should be addressed by consulting the appropriate diagnostic chart in "Diagnostics."

Following the output of Code 12, the Malfunction Indicator Lamp will indicate a diagnostic code three times if a code is present, or it will simply continue to output Code 12. If more than one diagnostic code has been stored in the ECM's memory, the codes will be output from the lowest to the highest, with each code being displayed three times.

If a scan tool is used to read the codes, follow the manufacturer's instructions.

SERVICE MODE

When the diagnostic code tool is installed at the Data Link Connector (DLC) and the selector switch is set at SERVICE, the system will enter what is called the SERVICE mode. In this mode the ECM will:

1. Display a Code 12 by flashing the Malfunction Indicator Lamp (indicating the system is operating correctly).
2. Display any stored codes by flashing the Malfunction Indicator Lamp. Each code will be flashed three times, then Code 12 will be flashed again.
3. The IAC valve moves to its fully extended position, blocking the idle air passage. This is important to remember, as an attempt to run the vessel while in SERVICE mode will most likely result in an abnormally low idle speed or a stalled engine.
4. Holds ignition advance steady.

NORMAL MODE

Engines can be monitored in the normal mode. Certain parameters can be observed without changing the engine operating characteristics.

Scan Tools

The ECM can communicate a variety of information through the DLC connector. This data is transmitted at a high frequency which requires a scan tool for interpretation.

With an understanding of the data which the tool displays, and knowledge of the circuits involved, the tool can be very useful in obtaining information which would be more difficult or impossible to obtain with other equipment.

Scan tools do not make the use of diagnostic charts unnecessary, nor can they indicate exactly where a problem is in a particular circuit. Tree charts incorporate diagnosis procedures using a scan tool where possible or a Diagnostic Code Tool (non-scan) if a scan tool is unavailable.

EFI Diagnostic Circuit Check

After the visual/physical inspection, the EFI Diagnostic Circuit Check is the starting point for all diagnostic procedures. Refer to EFI Diagnostic Circuit Check.

The correct procedure to diagnose a problem is to follow two basic steps.

1. Are the on-board diagnostics working? This is determined by performing the EFI Diagnostic Circuit Check. Since this is the starting point for the diagnostic procedures, always begin here. If the on-board diagnostics are not working, the EFI Diagnostic Circuit Check will lead to a diagnostic chart in "Diagnostics" to correct the problem. If the on-board diagnostics are working correctly, go to step 2.
2. If there is a code stored: If a code is stored, go directly to the numbered code chart in "Diagnostics." This will determine if the fault is still present.

Scan Tool Use with Intermittents

The scan tool allows manipulation of wiring harnesses or components with the engine not running, while observing the scan tool readout.

The scan tool can be plugged in and observed while running the vessel under the condition when the Malfunction Indicator Lamp turns ON momentarily or when the engine driveability is momentarily poor. If the problem seems to be related to certain parameters that can be checked on the scan tool, they should be checked while running the vessel. If there does not seem to be any correlation between the problem and any specific circuit, the scan tool can be checked on each position, watching for a period of time to see if there is any change in the readings that indicates intermittent operation.

The scan tool is also an easy way to compare the operating parameters of a poorly operating engine with those of a known good one. For example, a sensor may shift in value but not set a trouble code. Comparing the senor's readings with those of the typical scan tool data readings may uncover the problem.

The scan tool has the ability to save time in diagnosis and prevent the replacement of good parts. The key to using the scan tool successfully for diagnosis lies in the technician's ability to understand the system he is trying to diagnose as well as an understanding of the scan tool operation and limitations. The technician should read the tool manufacturer's operating manual to become familiar with the tool's operation.

CLEARING CODES USING DIAGNOSTIC CODE TOOL (NON-SCAN)

1. Install diagnostic code tool.
2. Turn key ON.
3. Select service mode on code tool.
4. To clear codes, move the throttle, while in neutral, from 0% to 100% then back to 0%.
5. Exit “Service Mode” on code tool.
6. Start engine and let run for fifteen seconds.
7. Turn key OFF for 5 seconds.
8. Select “Service Mode” on code tool.
9. Turn key ON and read codes. If codes are still present, check note following and repeat from Step 1.
10. Refer to appropriate Troubleshooting and/or Diagnostic Charts

A poorly charged battery or engine cranking problem may result in an ECM “reset” and may not allow stored trouble codes to be cleared from EEPROM memory. If this condition exists, BE SURE the battery is fully charged.

NOTE: If a low battery condition does exists the audio warning buzzer will come on for 2 seconds after engine start-up.

CLEARING CODES USING SCAN TOOL (SCAN)

1. Connect scan tool.
2. Start engine.
3. Select clear codes function.
4. Clear codes.
5. Turn key OFF.
6. Turn key ON and read codes. If codes are still present, (there is a real fault in system) check following note and repeat Step 1.

NOTE: *When clearing codes without the use of a scan tool, the battery must be fully charged. The ability to clear codes is directly dependent on the battery being fully charged and able to start the engine with adequate cranking RPM.*

Non-Scan Diagnosis of Driveability Concerns (With No Codes Set)

If a driveability concern still exists after following the diagnostic circuit check and reviewing “Troubleshooting,” an out-of-range sensor may be suspected. Because of the unique design of the EFI system, fail-safes have been incorporated into the ECM to replace a sensed value with a default value in the case of a sensor malfunction or sensor wiring concern. By allowing this to occur, limited engine performance is restored until the vessel is repaired. A basic understanding of sensor operation is necessary in order to diagnose an out-of-range sensor.

If the sensor is within its working or acceptable parameters, as shown, the ECM does not detect a problem. If the sensor should happen to fall out of this “window,” a code will be stored. A known default value will replace the sensed value to restore engine performance.

If the sensor is out of range, but still within the operating window of the ECM, the problem will go undetected by the ECM and may result in trouble later.

A good example of this would be if the coolant sensor was reading incorrectly and indicating to the ECM that coolant temperature was at 20° F, but actual coolant temperature was 175° F. This would cause the ECM to deliver more fuel than was actually needed and result in an overly rich, rough running condition. This condition would not have caused a code to set as the ECM interprets this as within its range.

To identify a sensor which is out of range, unplug it while running the engine. After approximately two minutes, the diagnostic code for that sensor will set, a code, and replace the sensed value with a default value. If at that point a noticeable performance increase is observed, the non-scan code chart for that particular sensor should be followed to correct the problem.

NOTE: *Be sure to clear each code after disconnecting and reconnecting each sensor. Failure to do so may result in a misdiagnosis of the problem.*

Special Tools

Part Number	Tool Name	Description
J-34029-A(Note 1)	High Impedance Multi-meter (DVM)	Minimum 10 megohm input impedance required on all voltage ranges. As ammeter, accurately measures low value current flow. As ohmmeter, reads 0-200 ohms, 2/20/200 kΩ, 2/20 mΩ
J-23738	Vacuum Pump with Gauge - 20 In. Hg Minimum	Gauge monitors manifold engine vacuum. Hand pump used to check fuel pressure regulator
J-34142-B (Note 2)	Unpowered Test Light	Used to check circuit wiring, short to ground, or voltage.
91-99379	Timing Light	Used to check ignition timing. Must have inductive signal pickup.
91-16850A-1	Fuel Pressure Gauge	Used to check fuel system pressure.
J-34730-2A	Injector Harness Test Light	Visually indicates injector electrical impulses from the ECM.
91-823686A2	Quicksilver Scan Tool	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system.
84-822560A2	MERCRUISER Cable	
91-822608--1	MERCRUISER Cartridge	
94040M	EFI Scan Tool/Injector Tester (Rinda Technologies)	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system. Allows for test firing injectors.
94008	Diagnostic Code Tool (Rinda Technologies)	Flashes light to display problem codes
J-35616	Harness Test Adapter	Allows multi-meter connections with wiring harness.
91-805918	Fuel Shut Off Tool	Used to perform fuel system pressure tests
91-805747A1	Timing Tool Jumper Plug	Used to set Ignition timing. Plug connects to DLC
91-806901	Fuel Line Connector	Allows connection of Fuel Pressure Gauge

NOTE 1: The High Impedance Multimeter that comes with the existing Outboard EFI Tester (91-11001A1) meets the requirements listed above.

NOTE 2: Using a test light with 100 mA or less rating may show a faint glow when test actually states no light.

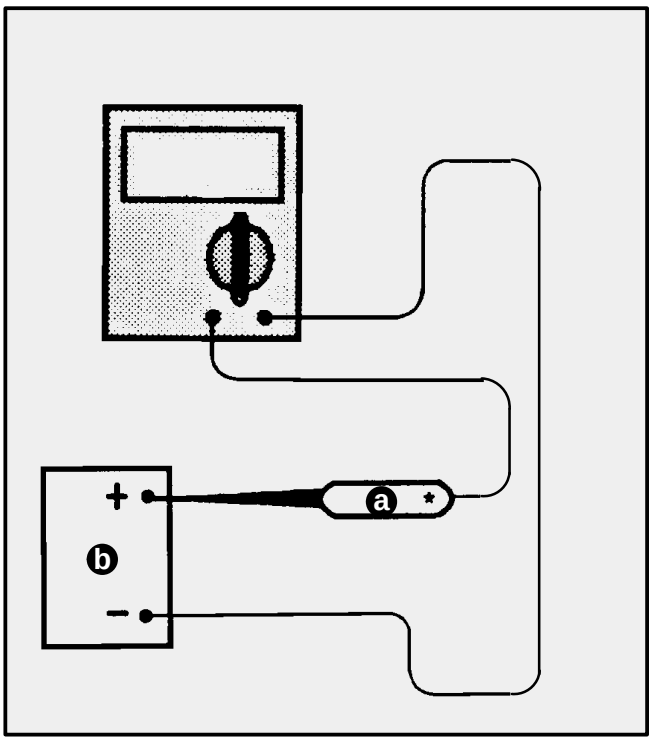
Kent-Moore Tools, Inc.
29784 Little Mack
Roseville, MI 48066
Phone: 800-345-2233

Rinda Technologies
4563 N. Elston Ave.
Chicago, IL 60630
Phone: 312-736-6633

Service Precautions

The following requirements must be observed:

1. Before removing any ECM system component, disconnect the negative battery cable.
2. Never start the engine without the battery being solidly connected.
3. Never separate the battery from the on-board electrical system while the engine is running.
4. Never separate the battery feed wire from the charging system while the engine is running.
5. When charging the battery, disconnect it from the boat's electrical system.
6. Ensure that all cable harnesses are connected solidly and that battery connections are thoroughly clean.
7. Never connect or disconnect the wiring harness at the ECM when the ignition is switched ON.
8. Before attempting any electric arc welding, disconnect the battery leads and the ECM connector(s).
9. When steam cleaning engines, do not direct the steam cleaning nozzle at ECM system components. If this happens, corrosion of the terminals or damage of components can take place.
10. Use only the test equipment specified in the diagnostic charts, since other test equipment may either give incorrect results or damage good components.
11. All voltage measurements using a voltmeter require a digital voltmeter with a rating of 10 megohms input impedance.
12. When a test light is specified, a "low-power" test light must be used. DO NOT use a high-wattage test light. While a particular brand of test light is not suggested, a simple test, as shown below, on any test light will ensure it to be safe for system circuit testing. Connect an accurate ammeter (such as the high impedance digital multimeter) in series with the test light being tested, and power the test light ammeter circuit with the vehicle battery.



a - Test Light
b - Battery

IMPORTANT: If the ammeter indicates **LESS** than 3/10 amp. current flow (.3 A or 300 mA), the test light is SAFE to use.
If the ammeter indicates **MORE** than 3/10 amp. current flow (.3 A or 300 mA), the test light is NOT SAFE to use.

NOTE: *Using a test light with 100 mA or less rating may show a faint glow when test actually states no light.*

13. When using a DVOM to perform voltage measurements, turn the ignition OFF when connecting the DVOM to the circuitry to be tested.

Electronic Control Module (ECM) and Sensors

General Description

The MerCruiser Electronic Fuel Injection system is equipped with a computer that provides the operator with state-of-the-art control of fuel and spark delivery. Computers use voltage to send and receive information.

Computers and Voltage Signals

Voltage is electrical pressure. Voltage does not flow in circuits. Instead, voltage causes current. Current does the real work in electrical circuits. It is current, the flow of electrically charged particles, that energizes solenoids, closes relays and lights lamps.

Besides causing currents in circuits, voltage can be used as a signal. Voltage signals can send information by changing levels, changing waveform (shape), or changing the speed at which the signal switches from one level to another. Computers use voltage signals to communicate with one another. The different sections inside computers also use voltage signals to communicate with each other.

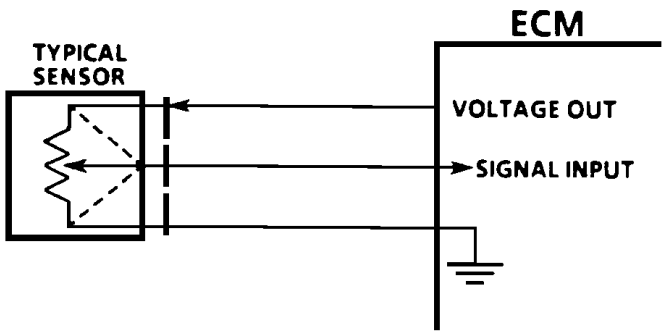
There are two kinds of voltage signals, analog and digital. Both of these are used in computer systems. It's important to understand the difference between them and the different ways they are used.

Analog Signals

An analog signal is continuously variable. This means that the signal can be any voltage within a certain range. An analog signal usually gives information about a condition that changes continuously over a certain range. For example, in a marine engine, temperature is usually provided by an analog signal. There are two general types of sensors that produce analog signals: the 3-wire and the 2-wire sensor.

THREE-WIRE SENSORS (MAP AND TP)

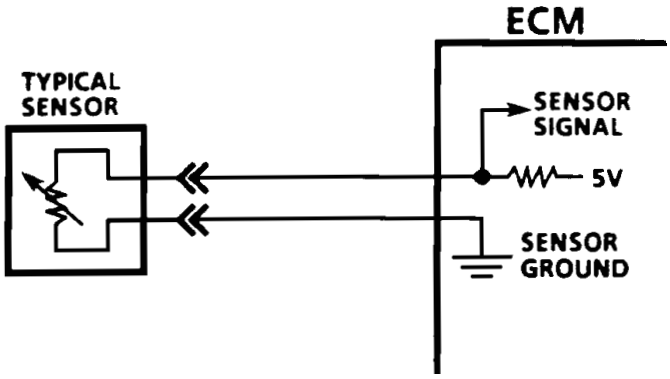
The following figure shows a schematic representation of a 3-wire sensor. All 3-wire sensors have a reference voltage, a ground and a variable "wiper." The lead coming off of the wiper will be the signal to the Engine Control Module (ECM). As this wiper position changes, the signal voltage returned to the computer also changes.



3-Wire Sensor

TWO-WIRE SENSORS (ECT AND IAT)

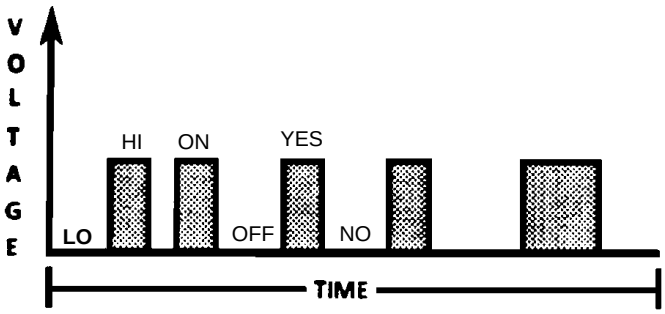
The following figure is the schematic of a 2-wire type sensor. This sensor is basically a variable resistor in series with a fixed-known resistor within the computer. By knowing the values of the input voltage and the voltage drop across the known resistor, the value of the variable resistor can be determined. The variable resistors that are commonly used are called thermistors. A thermistor's resistance varies inversely with temperature.



2-Wire Sensor

Digital Signals

Digital signals are also variable, but not continuously. They can only be represented by distinct voltages within a range. For example, 1 V, 2 V or 3 V would be allowed, but 1.27 V or 2.65 V would not. Digital signals are especially useful when the information can only refer to two conditions - “YES” and “NO,” “ON” and “OFF,” or “High” and “Low.” This would be called a digital binary signal. A digital binary signal is limited to two voltage levels. One level is a positive voltage, the other is no voltage (zero volts). As you can see in the following figure, a digital binary signal is a square wave.



Digital Binary Signal

The computer uses digital signals in a code that contains only ones and zeros. The high voltage of the digital signal represents a one (1), and no voltage represents a zero (0). Each zero and each one is called a bit of information, or just a “bit.” Eight bits together are called a “word.” A word, therefore, contains some combination of eight binary code bits: eight ones, eight zeros, five ones and three zeros, and so on.

Binary code is used inside a computer and between a computer and any electronic device that understands the code. By stringing together thousands of bits, computers can communicate and store an infinite variety of information. To a computer that understands binary, 11001011 might mean that it should reset engine RPM at a lower level. Although the computer uses 8-bit digital codes internally and when talking to another computer, each bit can have a meaning.

SWITCH TYPES

Switched inputs (also known as discretes) to the computer can cause one bit to change, resulting in information being communicated to the computer. Switched inputs can come in two types: they are “pull-up” and “pull-down” types. Both types will be discussed.

With a pull-up type switch, the ECM will sense a voltage when the switch is CLOSED. With the pull-down switch, the ECM recognizes the voltage when the switch is OPEN.

Discretes can also be used to inform a computer of FREQUENCY information.

PULSE COUNTERS

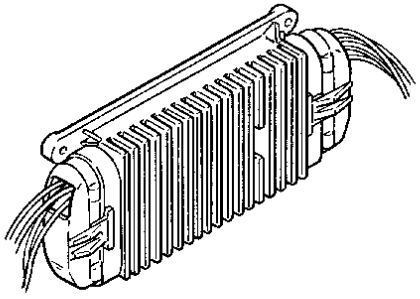
For the computer to determine frequency information from a switched input, the computer must measure the time between voltage pulses. As a number of pulses are recorded in a set amount of time, the computer can calculate the frequency. The meaning of the frequency number can have any number of meanings to the computer.

An example of a pulse counter type of input is the distributor reference pulse input. The computer can count a train of pulses, a given number of pulses per engine revolution, and determine the RPM of the engine.

Engine Control Module (ECM)

The Engine Control Module (ECM) is the control center of the fuel injection system. It constantly monitors information from various sensors, and controls the systems that affect engine performance.

The ECM also performs a diagnostic function check of the system. It can recognize operational problems and store a code or codes which identify the problem areas to aid the technician in making repairs.



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Electronic Control Module (ECM)

ECM FUNCTION

The ECM supplies 5 or 12 volts to power various sensors or switches. This is done through resistances in the ECM which are so high in value that a test light will not light when connected to the circuit. In some cases, even an ordinary shop voltmeter will not give an accurate reading because its resistance is too low. Therefore, the use of a **10 megohm input impedance digital voltmeter** is required to assure accurate voltage readings.

MEMORY

There are three types of memory storage within the ECM: ROM, RAM and EEPROM.

ROM

Read Only Memory (ROM) is a permanent memory that is physically soldered to the circuit boards within the ECM. The ROM contains the overall control programs. Once the ROM is programmed, it cannot be changed. The ROM memory is non-erasable, and does not need power to be retained.

RAM

Random Access Memory (RAM) is the microprocessor “scratch pad.” The processor can write into, or read from, this memory as needed. This memory is erasable and needs a constant supply of voltage to be retained.

EEPROM

Electronic Erasable Programmable Read Only Memory (EEPROM) is the portion of the ECM that contains the different engine calibration information that is specific to each marine application.

Speed Density System

The Electronic Fuel Injection system is a speed and air density system. The system is based on “speed/density” fuel management.

Three specific data sensors provide the ECM with the basic information for the fuel management portion of its operation. That is, three specific signals to the ECM establish the engine speed and air density factors.

SPEED

The engine speed signal comes from the distributor’s High Energy Ignition (HEI) module to the ECM on the distributor reference high circuit. The ECM uses this information to determine the “speed” or RPM factor for fuel and ignition management.

DENSITY

Two sensors contribute to the density factor, the Intake Air Temperature (IAT) [Multi-Port models only] and the Manifold Absolute Pressure (MAP) sensors.

The IAT sensor is a 2-wire sensor that measures the temperature of the air entering the intake manifold. The IAT sensor is a thermistor that changes its resistance depending on the air temperature. When the temperature is low, the resistance is high, and when the temperature is high, the resistance is low.

The Manifold Absolute Pressure (MAP) sensor is a 3-wire sensor that monitors the changes in intake manifold pressure which results from changes in engine loads. These pressure changes are supplied to the ECM in the form of electrical signals.

As intake manifold pressure increases (vacuum decreases), the air density in the intake manifold also increases, and additional fuel is required.

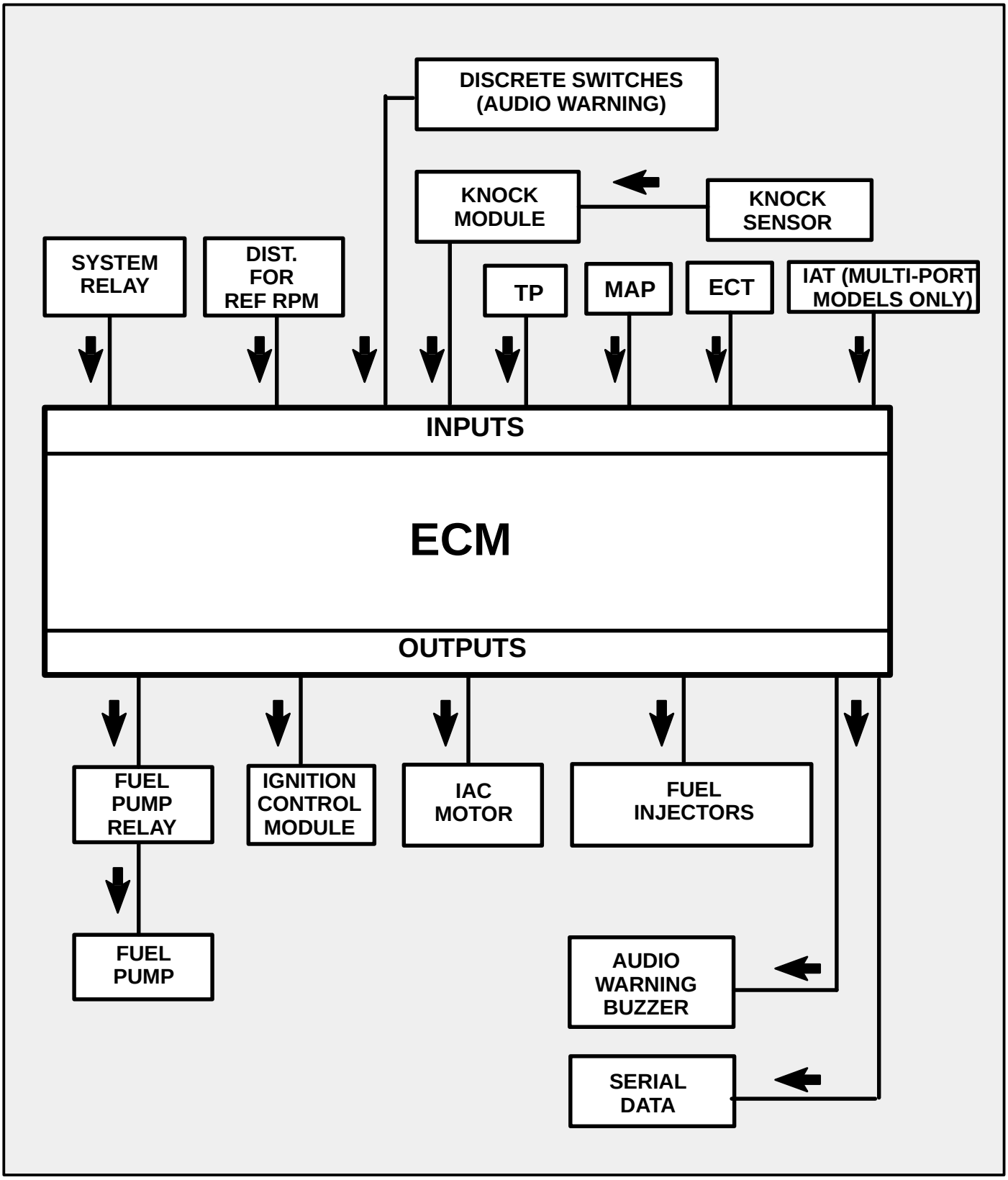
The MAP sensor sends this pressure information to the ECM, and the ECM increases the amount of fuel injected by increasing the injector pulse width. As manifold pressure decreases (vacuum increases), the amount of fuel is decreased.

These three inputs MAP, IAT and RPM are the major determinants of the air/fuel mixture, delivered by the fuel injection system.

The remaining sensors and switches provide electrical inputs to the ECM which are used for modification of the air/fuel mixture, as well as for other ECM control functions, such as Idle Air Control (IAC).

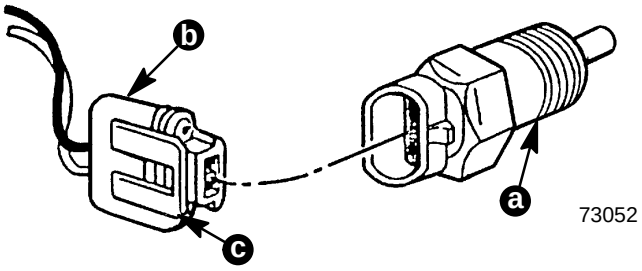
ECM Input and Sensor Descriptions

The following lists the sensors, switches, and other inputs used by the ECM to control its various systems. Although we will not cover them all in great detail, there will be a brief description of each.



ENGINE COOLANT TEMPERATURE (ECT) SENSOR

The Engine Coolant Temperature (ECT) Sensor is a thermistor (a resistor which changes value based on temperature) immersed in the engine coolant stream. Low coolant temperature produces a high resistance, while high temperature causes low resistance.



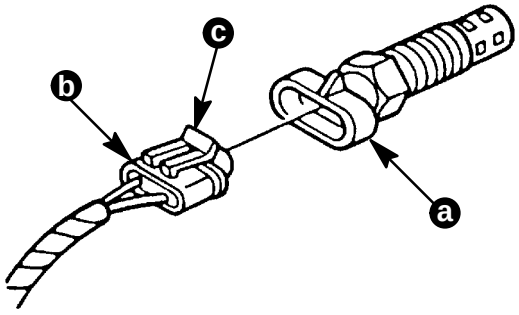
a - Engine Coolant Temperature (ECT) Sensor
b - Harness Connector
c - Locking Tab

The ECM supplies a 5 volt signal to the ECT through a resistor in the ECM and measures the voltage. The voltage will be high when the engine is cold, and low when the engine is hot. By measuring the voltage, the ECM knows the engine coolant temperature. Engine coolant temperature affects most systems the ECM controls.

A failure in the ECT circuit should set Code 14. Remember, this code indicates a failure in the coolant temperature sensor circuit, so proper use of the chart will lead to either repairing a wiring problem or replacing the sensor.

INTAKE AIR TEMPERATURE (IAT) SENSOR [MULTI-PORT INJECTION MODELS ONLY]

The Intake Air Temperature (IAT) sensor is a thermistor (a resistor which changes value based on temperature) mounted on the underside of the plenum. Low temperature produces a high resistance, while high temperature causes a low resistance.



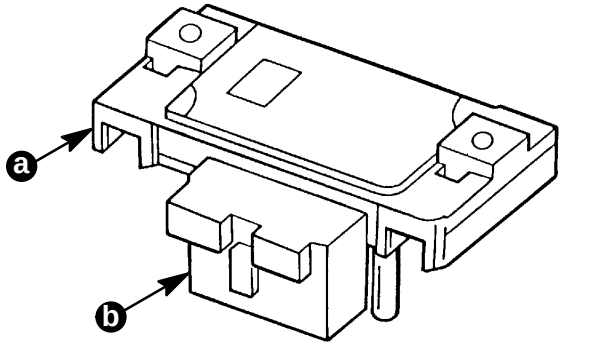
a - Intake Air Temperature (IAT) Sensor
b - Harness Connector
c - Locking Tab

The ECM supplies a 5 volt signal to the sensor through a resistor in the ECM and measures the voltage. The voltage will be high when the intake air is cold, and low when the intake manifold air is hot.

A failure in the IAT sensor circuit should set a Code 23.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The Manifold Absolute Pressure (MAP) sensor is a pressure transducer that measures the changes in the intake manifold pressure. The pressure changes as a result of engine load and speed change, and the MAP sensor converts this to a voltage output.



a - Manifold Absolute Pressure (MAP) Sensor
b - Electrical Connector

A closed throttle on engine coast-down would produce a relatively low MAP output voltage, while a wide open throttle would produce a high MAP output voltage. This high output voltage is produced because the pressure inside the manifold is the same as outside the manifold, so 100% of outside air pressure is measured. When manifold pressure is high, vacuum is low. The MAP sensor is also used to measure barometric pressure under certain conditions, which allows the ECM to automatically adjust for different altitudes.

The ECM sends a 5 volt reference signal to the MAP sensor. As the manifold pressure changes, the electrical resistance of the MAP sensor also changes. By monitoring the sensor output voltage, the ECM knows the manifold pressure. A higher pressure, low vacuum (high voltage) requires more fuel, while a lower pressure, higher vacuum (low voltage) requires less fuel. The ECM uses the MAP sensor to control fuel delivery and ignition timing.

A failure in the MAP sensor circuit should set a Code 33.

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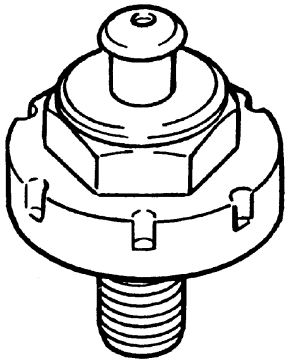
KNOCK SENSOR

The knock sensor is mounted on the lower right side of the engine block.



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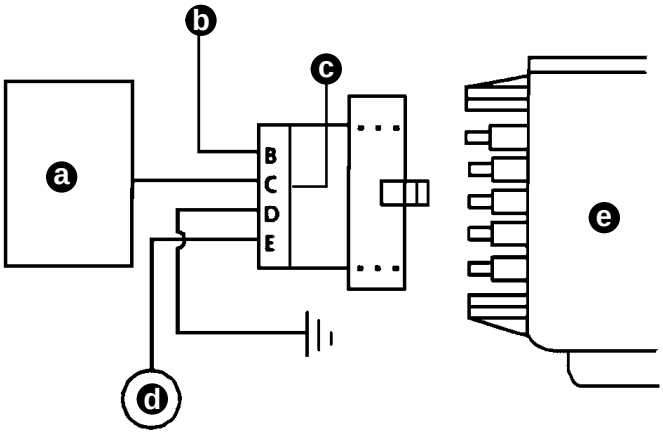
When abnormal engine vibrations (spark knock) are present, the sensor produces a voltage signal which is sent to the KS Module and then to the ECM. The ECM uses this signal to aid in calculating ignition timing.

KNOCK SENSOR (KS) MODULE

The KS module contains solid state circuitry which monitors the knock sensor's AC voltage signal and then supplies an 8-10 volt signal, if no spark knock is present, to the ECM. If spark knock is present, the KS module will remove the 8-10 volt signal to the ECM.



Knock Sensor System

a - Electronic Control Module (ECM)
b - 12 Volts Battery Positive
c - 8-12 Volts
d - Knock Sensor
e - Knock Sensor Module

It is extremely important that the correct KS sensor and module be used for the engine application. Using an incorrect KS module will result in unrecognized spark knock and engine damage. The KS module terminal B is powered by 12 volts from the ignition switch thru system relay. If the 12 volt power source is not present, the KS module cannot send an 8-10 volt signal to the ECM and a false constant spark retard will result. A code 43 will be set.

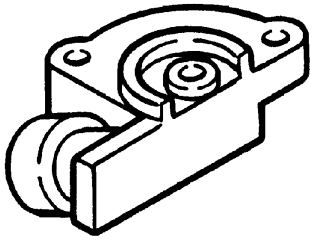
Terminal E of the KS module is the signal line from the knock sensor. If this circuit opens or shorts to ground, the KS module will never remove the 8-10 volt signal from terminal C to the ECM and no spark retard will occur. The ground circuit for the KS module is connected to terminal D. If the ground circuit opens, the KS module will not be able to remove the 8-10 volt signal to the ECM and spark knock cannot be controlled.

On certain models **(serial number OF417516 and below)**, the ECM will do a self test when the following conditions are reached:

- Engine temperature above 150° F (66° C).
- Engine RPM above 4000 RPM.
- 5.024 Hg in. (80 kPa) manifold pressure

THROTTLE POSITION (TP) SENSOR

The Throttle Position (TP) Sensor is a potentiometer connected to the throttle shaft on the throttle body. The TP has one end connected to 5 volts from the ECM and the other to ECM ground. A third wire is connected to the ECM to measure the voltage from the TP. As the throttle valve angle is changed, the voltage output of the TP also changes. At a closed throttle position, the voltage output of the TP is low (approximately .5 volt). As the throttle valve opens, the output increases so that at wide-open-throttle (W.O.T.), the output voltage should be near 4.5 volts. By monitoring the output voltage from the TP, the ECM can determine fuel delivery based on throttle valve angle (driver demand). A broken or loose TP can cause intermittent bursts of fuel from the injector and an unstable idle, because the ECM thinks the throttle is moving.



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If the TP circuit is open, the ECM will set a Code 21. If the TP circuit is shorted, and a trouble Code 21 will be set. A problem in any of the TP circuits will set a Code 21. Once a trouble code is set, the ECM will use a default value for TP.

DISTRIBUTOR REFERENCE (DIST REF)

The distributor reference (engine speed signal) is supplied to the ECM by way of the “Dist Ref Hi” line from the High Energy Ignition (HEI). This pulse counter type input creates the timing signal for the pulsing of the fuel injectors, as well as the Ignition Control (IC) functions. This signal is used for a number of control and testing functions within the ECM.

DISCRETE SWITCH INPUTS - POWER REDUCTION MODE (1996 AND OLDER MODELS)

Several discrete switch inputs are utilized by the system to identify abnormal conditions that may affect engine operation. Pull-down switches are used in conjunction with the ECM to detect critical conditions to engine operation.

If a switch changes state from its normal at rest position, that is normally open to closed, the ECM senses a change in voltage and responds by entering power reduction mode.

This engine protection feature allows the operator full engine power up to 2800 RPM, but disables half of the fuel injectors above 2800 RPM until the engine RPM drops to 1200 RPMS.

This feature allows the operator a comfortable maneuvering speed while removing the possibility of high RPM engine operation until the problem is corrected.

Switches which are used with the Fuel Injection system to detect critical engine operation parameters are:

Switch	Normal State
Oil Pressure	N/O
I/O Fluid Level on Stern Drive	N/O
Transmission Temperature on MIE Models	N/O
Engine Coolant Temperature	N/O

IMPORTANT: Models equipped with multiple engines must use dual engine data link kit and common ground between engine blocks. Otherwise there will be no serial data communication between engines and the power reduction mode will not control both engines.

- Triple (three) engine applications should connect the outboard engines.
- Quad (four) engine applications Should link the outer two outboard engines with one link and the two inboard engines with another link.

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Spark Management

High Energy Ignition with Ignition Control (IC)

The Electronic Fuel Injection is controlled by an Engine Control Module (ECM). This module is the nerve/decision center of the system. It uses all the information it gathers to manage ignition spark, delivering increased fuel economy and maximum engine performance.

The system uses inputs from sensors to make decisions on the amount of spark advance or retard allowed.

The system has been designed to control ignition advance and retard electronically by the ECM.

In order for the ECM to properly calculate spark advance, it must always know at what speed the engine is running. The engine speed signal is accomplished by a circuit within the distributor module which converts the pickup coil voltage to a square wave reference signal that can be used by the ECM. This square wave engine speed reference signal is known as REF HI. The ECM must also have something to compare the REF HI value against. Therefore, an additional line is provided between the ECM and the distributor module that is known as REF LO. These two lines, between the ECM and the distributor, provide a precise indication of engine speed.

The two other lines between the ECM and distributor which control the Ignition Control (IC) operation are known as the bypass and IC circuits.

Modes Of Operation

There are two modes of ignition system operation:

DISTRIBUTOR MODULE MODE

The ignition system operates independent of the ECM. The distributor module module in the distributor maintains a base ignition timing and is able to advance timing to a total of 27 degrees. This mode is in control when a Code 42 is detected while engine is running and will have a noticeable affect on engine operation.

ECM CONTROL MODE

The ECM control mode controls the ignition timing. The ECM calculates the desired ignition timing based on information it gets from its input sensors.

Distributor Module Mode

The following describes IC operation during cranking and when the engine starts running. To help understand how IC circuits operate, a relay with a double set of contact points is shown in the IC module (refer to the figures “Ignition Control Mode” and “ECM Control Mode”). Solid state circuitry is used in the module, but showing the relay makes it easier to visualize how the IC module functions.

During cranking, the relay is in the de-energized position (see figure “Distributor Module Mode”). This connects the pickup coil to the base of the transistor via the signal converter. When the pickup coil applies a positive voltage to the transistor, the transistor turns ON. When voltage is removed, the transistor turns OFF. When the transistor turns ON, current flows through the primary winding of the ignition coil. When it turns OFF, the primary current stops and a spark is developed at the spark plug. A small amount of advance is built into the IC module via a timing circuit, in case the engine remains in the ignition module timing mode.

With the relay de-energized, a set of contacts (shown closed) would ground the IC line signal.

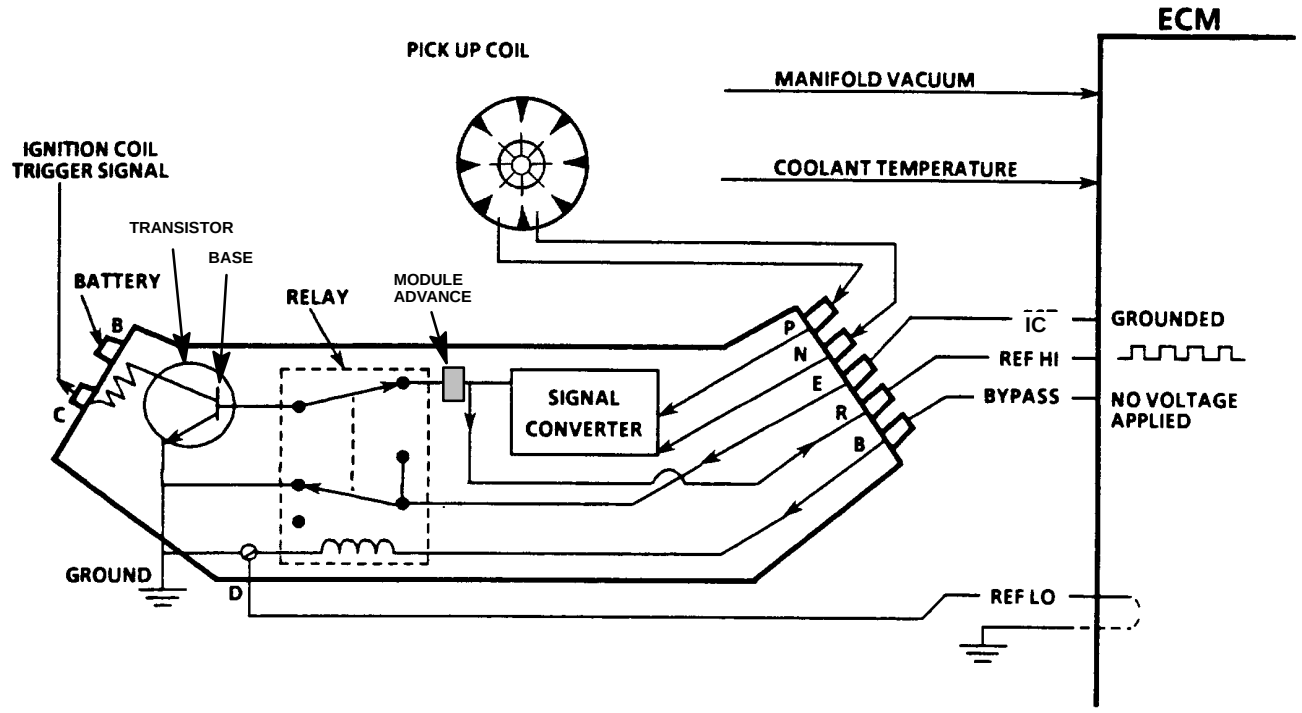
ECM Control Mode

When the engine RPM reaches a predetermined value (for this example, 300 RPM), the ECM considers the engine running and applies five volts on the bypass line to the IC module. This energizes the relay and causes the contacts from the pickup coil as well as the grounding contacts for the IC line to open (see figure “ECM Control Mode”). This connects the IC line to the base of the transistor, and bypasses the ignition module timing control.

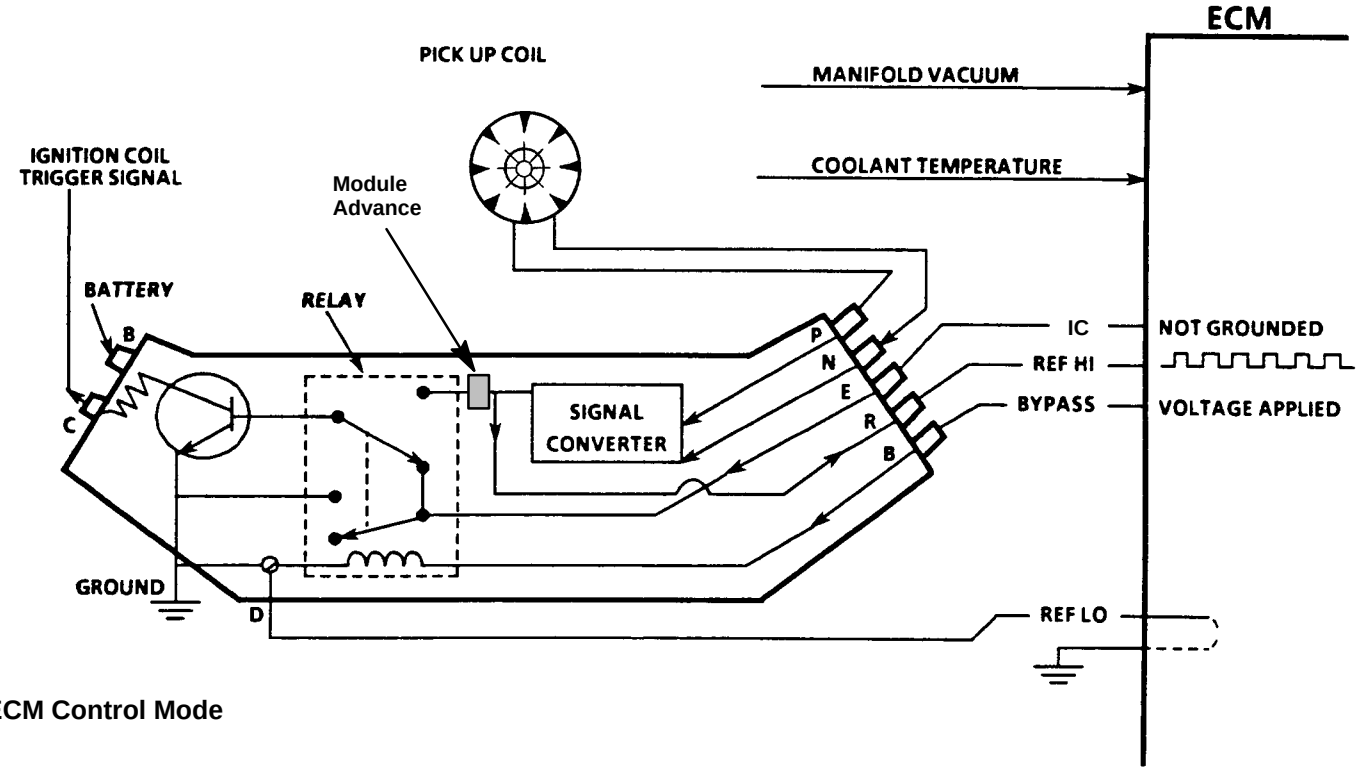
The IC system is now controlled by the IC signal from the ECM and the time at which the spark occurs can be determined by a variable time circuit in the ECM.

Base Ignition Timing

In order to check or change base timing on a HEI system the ECM has to be entered into the service mode by using a scan tool or code tool. The IC module will go to base timing. The ECM will stabilize timing to allow timing adjustment. The ECM incorporates a spark control override, which allows timing to be lowered if spark knock (detonation) is encountered during normal operation. At this time, the timing can be adjusted by turning the distributor.



Distributor Module Mode



ECM Control Mode

Results of Incorrect Operation

Open IC Line from the ECM to the Distributor Module - While the engine is cranking, the ECM expects to see the IC signal pulled to virtually zero because it is grounded in the distributor module. Since the IC line is open, it cannot be grounded by the module and the IC signal will be able to rise and fall, or do what is called toggling. The ECM recognizes the toggling as an abnormal condition, and will not apply bypass voltage to the distributor module when the engine reaches run RPM.

Since bypass voltage is not applied to the relay, it remains open and the engine continues to run on the pickup coil triggering in the ignition module timing mode.

If this condition occurs while the engine is running, the engine will stop, but it will restart and run in the ignition module timing mode with reduced power.

Grounded IC Line - During cranking, the IC voltage is at virtually zero so the ECM does not recognize a problem. When engine RPM reaches the value for the run condition, the ECM applies bypass voltage to the distributor module. Bypass voltage on the module switches the distributor power transistor to the IC line. Because the IC line is grounded, it will have no voltage applied so it cannot operate the power transistor to enter the IC mode.

If the IC line becomes grounded while the engine is being operated, the engine will stop and will be difficult to restart.

An open or ground in the IC or bypass will cause the engine to run on the distributor module timing. This will cause reduced performance, poor fuel economy and erratic idle.

Grounded or Open Bypass Line - While the engine is cranking, the IC line will be grounded and the ECM will not notice anything abnormal. When run RPM is reached, the ECM applies bypass voltage to the bypass line but because of the ground or open, it will not be able to energize the relay. Therefore, the relay will stay de-energized and the IC line will remain grounded.

When the ECM sees the IC line not toggling, it will not enter the IC mode. Since the relay is de-energized, the engine will continue to run in the ignition module timing mode.

If this condition occurs while the engine is running, the engine will simply operate in the ignition module timing mode.

Open or Grounded REF HI Line - This line provides the ECM with engine speed information. If this line is open or grounded, the ECM will not know that the engine is cranking or running and will not run.

Open or Grounded REF LO Line - This wire is grounded in the ignition module and provides a reference ground from the ignition module to the ECM. The ECM compares reference ground with reference high voltage. If this circuit is open, or grounded at any other location than through the module, it may cause poor performance.

Fuel Metering System

General Description

The function of the fuel metering system is to deliver the correct amount of fuel to the engine under all operating conditions.
Multi-Port Injection, fuel is delivered to the engine by individual fuel injectors mounted in the intake manifold near each cylinder.
Throttle Body Injection, fuel is delivered from two injectors mounted atop the intake manifold.

Modes of Operation

The ECM looks at voltages from several sensors to determine how much fuel to give the engine. The fuel is delivered under one of several conditions, called modes. All the modes are controlled by the ECM and are described below.

STARTING MODE

When the ignition switch is turned to the crank position, the ECM turns ON the fuel pump relay and the fuel pump builds up pressure. The ECM then checks the Engine Coolant Temperature (ECT) sensor and Throttle Position (TP) sensor and determines the proper air/fuel ratio for starting. The ECM controls the amount of fuel delivered in the starting mode by changing how long the injectors are turned ON and OFF. This is done by pulsing the injectors for very short times.

CLEAR FLOOD MODE

If the engine floods, it can be cleared by opening the throttle half way (50%). (Open throttle handle until resistance from secondary throttle [Multi-Port only] is felt.) The ECM discontinues fuel injector pulsation as long as the throttle is between 50 to 75 % and the engine RPM is below 300. If the throttle position becomes more than 75% or less than 50%, the ECM returns to the starting mode.

RUN MODE

When the engine is started and RPM is above 300, the system operates in the run mode. The ECM will calculate the desired air/fuel ratio based on these ECM inputs: RPM, Manifold Absolute Pressure (MAP) sensor, Intake Air Temperature (IAT) sensor and Engine Coolant Temperature (ECT) sensor . Higher engine load (from MAP) and colder engine temperature (from ECT) requires more fuel, or a richer air/fuel ratio.

ACCELERATION MODE

The ECM looks at rapid changes in Throttle Position (TP) and provides extra fuel by increasing the injector pulse width.

FUEL CUTOFF MODE

No fuel is delivered by the injectors when the ignition is OFF, to prevent dieseling. Also, fuel pulses are not delivered if the ECM receives no distributor reference pulses, which means the engine is not running. The fuel cutoff mode is also enabled at high engine RPM, as an overspeed protection for the engine. When cutoff is in effect due to high RPM, injection pulses will resume after engine RPM drops slightly.

POWER REDUCTION MODE (1996 AND OLDER MODELS)

The ECM will go into power reduction mode when the following conditions are met:

1. Low oil pressure
2. Engine overheat
3. Low I/O fluid level (MCM)
4. High transmission temperature (MIE)

The ECM recognizes change of state in a discrete switch input that identifies an abnormal condition that may affect proper drive train operation.

As an engine protection feature, power reduction mode allows normal fuel injection up to 2800 RPM. Above 2800 RPM, fuel delivery is limited to half of the injectors until RPM lowers to 1200 RPM when normal fuel injection resumes.

This feature maintains maneuverability of the vessel while removing the possibility of high RPM operation until the problem is corrected.

DECELERATION MODE

The IAC is similar to a carburetor dashpot. It provides additional air when the throttle is rapidly moved to the idle position to prevent the engine from dying.

Fuel Metering System Components

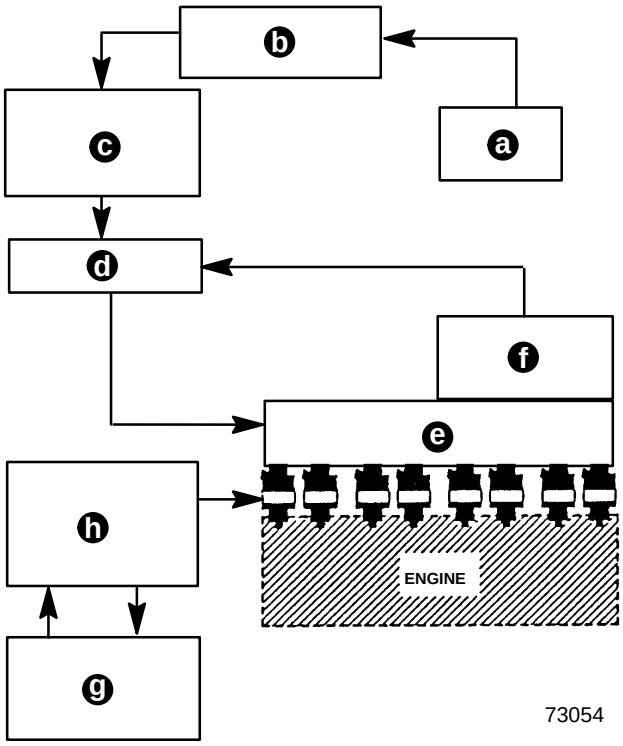
Multi-Port Vapor Separator Tank (VST)

The fuel metering system is made up of the following components:

- Fuel supply components (fuel tank, mechanical pump, lines, etc.).
- Vapor Separator Tank (VST).
- Fuel pump electrical circuit.
- Fuel rail assembly, including:

  Fuel injectors.

  Pressure regulator assembly.



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Fuel Metering System

a - Mechanical Fuel Pump
b - Vapor Separator Tank (VST)
c - Electronic Control Module
d - Network Of Engine Sensors
e - Water Separating Fuel Filter
f - Fuel Pressure Regulator
g - Fuel Rail Assembly
h - Fuel Tank

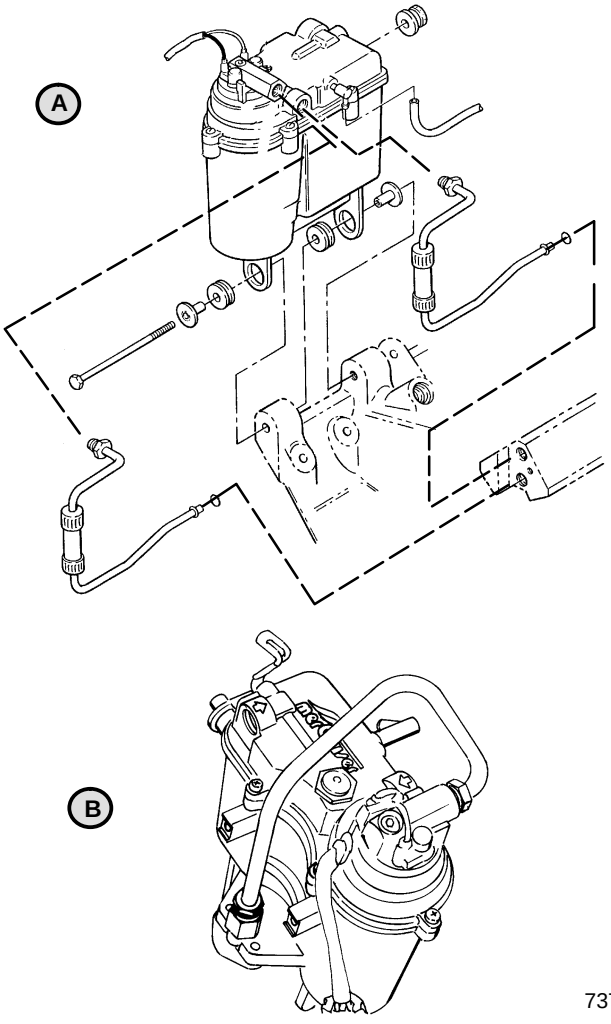
FUEL SUPPLY COMPONENTS

Fuel is drawn from the boat's fuel supply tank, through a water separating fuel filter, by a mechanical fuel pump mounted on and driven by a seawater pump, and is delivered to the Vapor Separator Tank (VST).

VAPOR SEPARATOR TANK (VST)

An electric fuel pump located in the VST pumps fuel to the fuel rail assembly. The pump is designed to provide fuel at a pressure greater than that required by the injectors. The pressure regulator, part of the fuel rail assembly, regulates fuel pressure to the fuel injectors. Unused fuel is returned to the VST.

NOTE: *MCM 454 Magnum Multi-Port with serial number (0F130438) and MCM 502 Magnum Multi-Port with serial number (0F128962) and higher will be equipped with fuel lines as shown in figure A. Fuel line shown in figure B is a replacement line per Service Bulletin 93-26. If VST does not have style A or B refer to to this service bulletin.*



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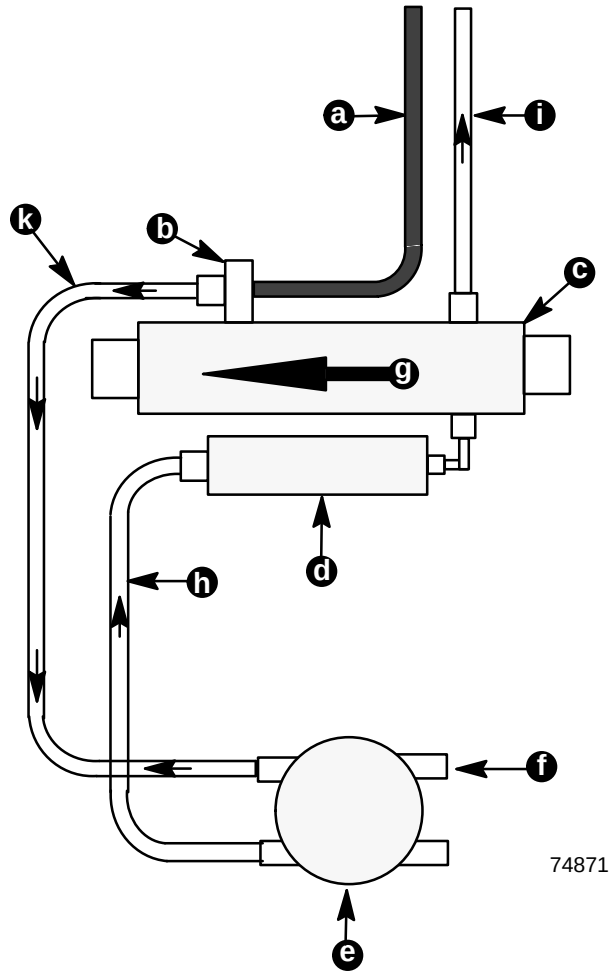
Cool Fuel System

The Cool Fuel System consists of an electrical fuel pump, water separating fuel filter and port mounted fuel cooler.

Fuel is drawn from the boat fuel tank through a water separating fuel filter by an electric fuel pump then through fuel cooler. Fuel is fed to fuel injectors in the throttle body (or fuel rail on multi-port injection system). Excess fuel is routed back to water separating fuel filter from the pressure regulator mounted on the fuel cooler.

FUEL FLOW DIAGRAM



Throttle Body Injection System (Typical)

a - Vacuum Line To Flame Arrestor (Throttle Body Injection) Or Fuel Rail (Multi-Port Injection)
b - Fuel Pressure Regulator
c - Fuel Cooler
d - Electric Fuel Pump
e - Water Separating Fuel Filter
f - Fuel From Tank
g - Direction Of Water Flow
h - Fuel Line To Fuel Pump
i - Fuel Line To Throttle Body (Throttle Body Injection) Or Fuel Rail (Multi-Port Injection)
j - Excess Fuel Return To Water Separating Fuel Filter

Throttle Body Injection Components

FUEL PUMP ELECTRICAL COMPONENTS

When the ignition switch is turned to the RUN position, the ECM will turn ON the fuel pump relay for two seconds.

When the ignition switch is turned to the crank position, the ECM turns the fuel pump relay ON causing the fuel pump to start.

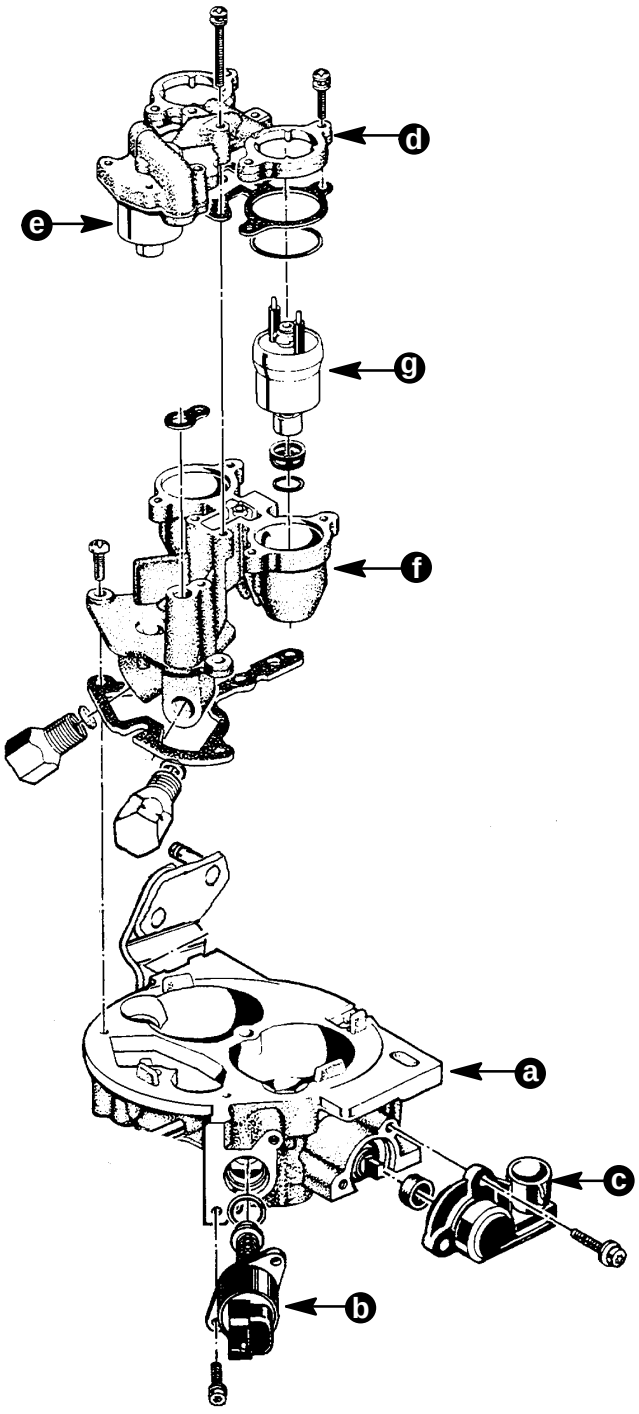
If the ECM does not receive ignition reference pulses (engine cranking or running), it shuts Off the fuel pump relay, causing the fuel pump to stop.

THROTTLE BODY UNIT

The throttle body unit consists of three assemblies.

- Fuel meter cover and fuel damper
- Fuel meter body and fuel injectors
- Throttle Body
  - -Two Throttle Valves To Control Air Flow Into The Engine
  - -Idle Air Control (IAC) Valve
  - -Throttle Position (Tp) Sensor

THROTTLE BODY UNIT EXPLODED VIEW



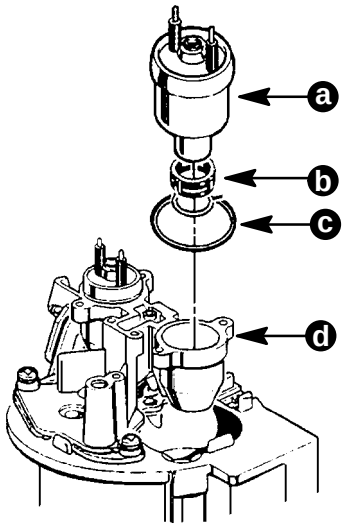
73766

a - Throttle Body
b - Idle Air Control (IAC) Valve
c - Throttle Position (TP) Sensor
d - Fuel Meter Cover
e - Fuel Damper
f - Fuel Meter Body
g - Fuel Injector (2)

FUEL INJECTORS

The injector assembly is a solenoid operated device, controlled by the ECM, that meters pressurized fuel to the intake manifold. The ECM energizes the injector solenoid, which opens a ball valve, allowing fuel to flow past the ball valve, and through a recessed flow director plate.

The director plate has six machined holes that control the fuel flow, generating a conical spray pattern of finely atomized fuel at the injector tip. Fuel is directed at the throttle, causing it to become further atomized before entering the intake manifold.

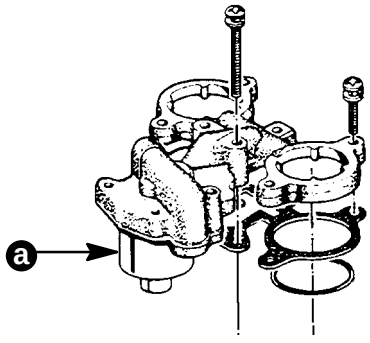


73773

a - Fuel Injector
b - Fuel Filter
c - Seal Ring
d - Fuel Meter Body

FUEL DAMPER

The fuel damper acts as an equalization device to reduce the pressure spikes caused by the fuel injectors.



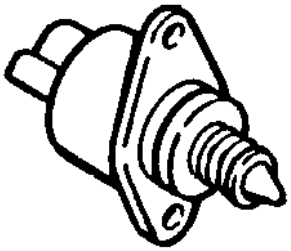
73766

Throttle Body Injection Shown

a - Fuel Damper

IDLE AIR CONTROL (IAC) VALVE

The purpose of the IAC valve assembly is to control engine idle speed, while preventing stalls due to changes in engine load. The IAC valve, mounted in the throttle body, controls bypass air around the throttle valves.



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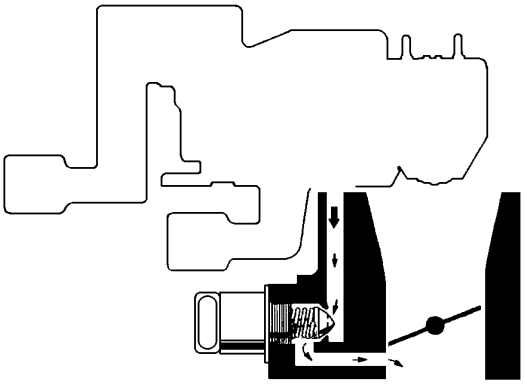


IAC Valve Air Flow Diagram

By moving a conical valve known as a pintle, IN, toward the seat (to decrease air flow), or OUT, away from the seat (to increase air flow), a controlled amount of air moves around the throttle valve. If RPM is too low, more air is bypassed around the throttle valve to increase it. If RPM is too high, less air is bypassed around the throttle valve to decrease it.

The ECM moves the IAC valve in small steps, called counts. These can be measured by scan tool test equipment, which plugs into the DLC.

During idle, the proper position of the IAC valve is based on engine RPM. If the RPM drops below specification and the throttle valve is closed, the ECM senses a near stall condition and calculates a new valve position to prevent stalling.

- Engine idle speed is a function of total air flow into the engine based on IAC valve pintle position + throttle valve stop screws and PCV.
- "Controlled" idle speed is programmed into the ECM, which determines the correct IAC valve pintle position to maintain the desired idle speed for all engine operating conditions and loads.
- The minimum idle air rate is set at the factory with stop screws. This setting allows enough air flow by the throttle valves to cause the IAC valve pintle to be positioned a calibrated number of steps (counts) from the seat during "controlled" idle operation.
- If the IAC valve is disconnected and reconnected with the engine running, the idle speed may be wrong. In this case, the IAC valve can be reset by doing the following: turn off engine, wait ten seconds, and restart engine.

Multi-Port Injection Components

FUEL PUMP ELECTRICAL CIRCUIT

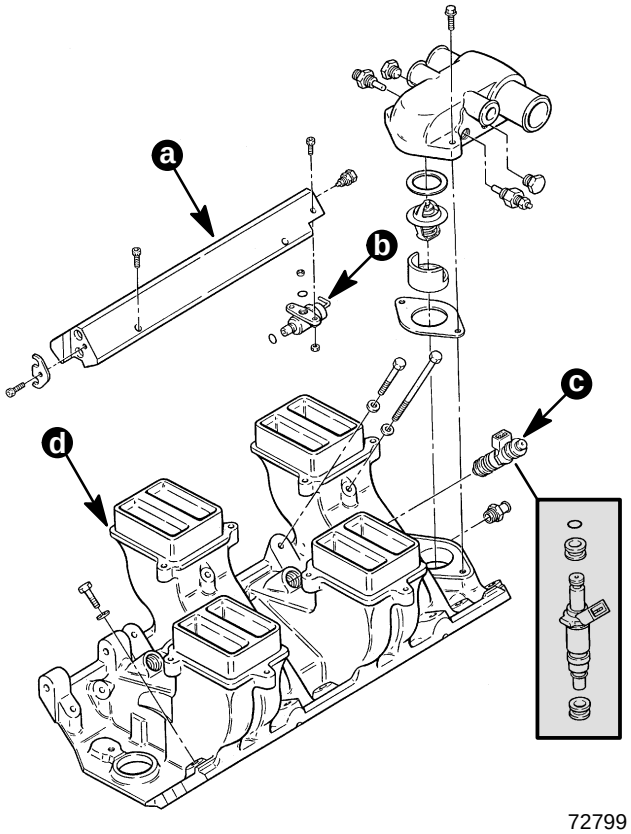
When the ignition switch is turned to the RUN position, the ECM will turn ON the fuel pump relay for two (2) seconds.

When the ignition switch is turned to the crank position, the ECM turns the fuel pump relay ON causing the fuel pump to start.

If the ECM does not receive ignition reference pulses (engine cranking or running), it shuts OFF the fuel pump relay, causing the fuel pump to stop.

FUEL RAIL/INTAKE MANIFOLD ASSEMBLY

The fuel rail performs several functions. It positions the injectors in the intake manifold, distributes fuel evenly to the injectors, and integrates the fuel pressure regulator into the fuel metering system.



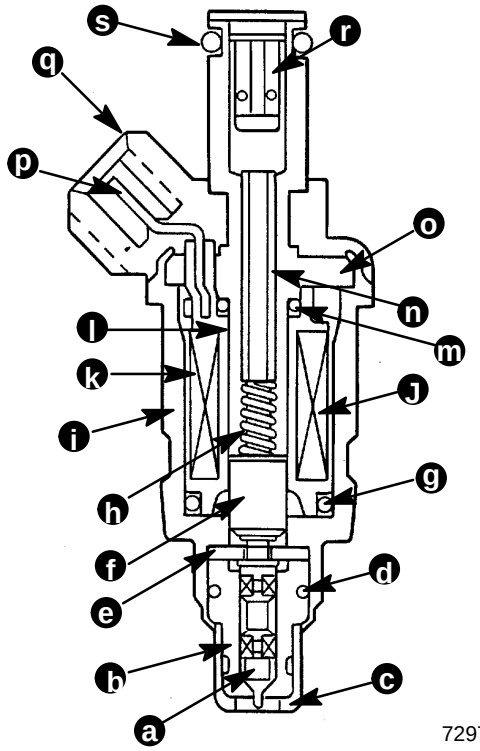
72799

a - Fuel Rail
b - Pressure Regulator
c - Fuel Injector
d - Intake Manifold

FUEL INJECTORS

The EFI injector assembly is a solenoid-operated device, controlled by the ECM, that meters pressurized fuel to a single engine cylinder. The ECM grounds the injector solenoid, which opens a pintle valve, allowing fuel to flow past the pintle valve. The injector tip has holes that control the fuel flow, generating a conical spray pattern of finely atomized fuel at the injector tip. Fuel is directed at the intake valve, causing it to become further atomized and vaporized before entering the combustion chamber.

An injector that is stuck partly open will cause loss of pressure after engine shutdown. This can result in long cranking times. Dieseling can also occur, because some fuel might be delivered to the engine after the ignition is turned OFF.

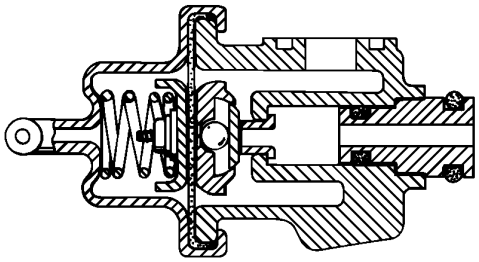


72970

a - Needle Valve
b - Nozzle
c - Cap
d - O-Ring
e - Valve Stopper
f - Core
g - O-Ring
h - Spring
i - Housing
j - Solenoid Coil
k - Tape
l - Bobbin
m - O-Ring
n - Inner Collar
o - Sleeve
p - Terminal
q - Connector
r - Filter
s - O-Ring

PRESSURE REGULATOR ASSEMBLY

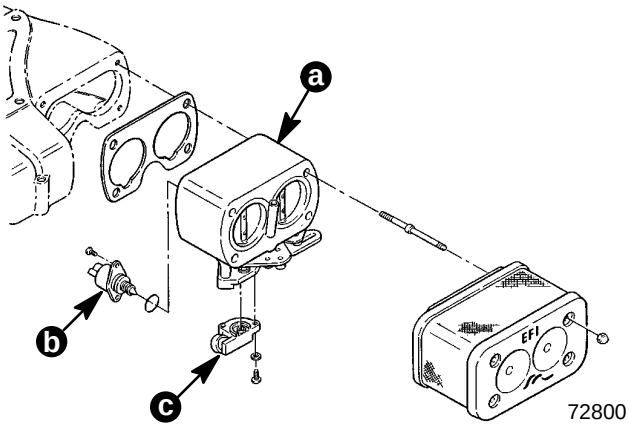
The pressure regulator is a diaphragm-operated relief valve with fuel pump pressure on one side, and regulator spring pressure and intake manifold vacuum on the other. The regulator's function is to maintain a constant pressure differential across the injectors at all times. The pressure regulator compensates for engine load by increasing fuel pressure as engine vacuum drops.


71716

Throttle Body Assembly

The throttle body assembly is attached to the plenum, and is used to control air flow into the engine, thereby controlling engine output. The throttle valves within the throttle body are opened by the operator through the accelerator controls. During engine idle, the throttle valves are almost closed, and air flow control is handled by the Idle Air Control (IAC) valve, described below.

The throttle body also provides the location for mounting the Throttle Position (TP) sensor for sensing throttle valve position.



72800

a - Throttle Body
b - Idle Air Control (IAC) Valve
c - Throttle Position Sensor

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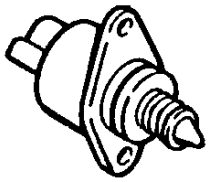
IDLE AIR CONTROL (IAC) VALVE

The purpose of the IAC valve assembly is to control engine idle speed, while preventing stalls due to changes in engine load. The IAC valve, mounted in the throttle body, controls bypass air around the throttle valves.



72800

Idle Air Control (IAC) Valve Assembly

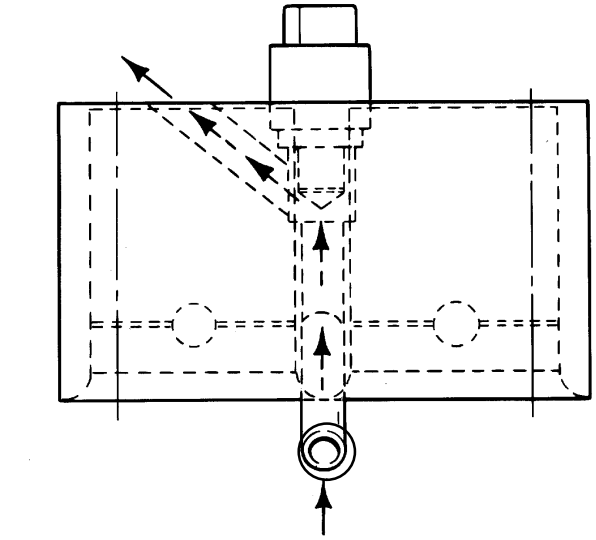
By moving a conical valve known as a pintle, IN, toward the seat (to decrease air flow), or OUT, away from the seat (to increase air flow), a controlled amount of air moves around the throttle valve. If RPM is too low, more air is bypassed around the throttle valve to increase it. If RPM is too high, less air is bypassed around the throttle valve to decrease it.

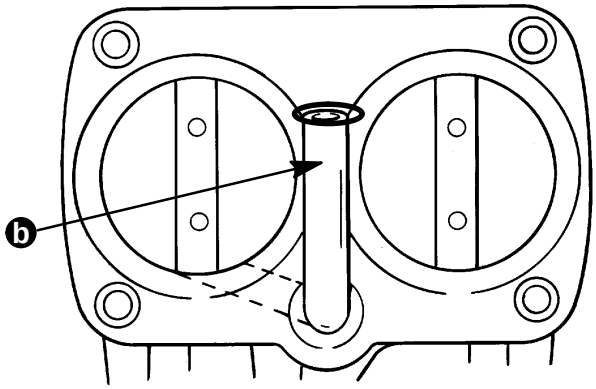
The ECM moves the IAC valve in small steps, called counts. These can be measured by scan tool test equipment, which plugs into the DLC connector.

During idle, the proper position of the IAC valve is engine load, and engine RPM. If the RPM drops below specification and the throttle valve is closed, the ECM senses a near stall condition and calculates a new valve position to prevent stalling.

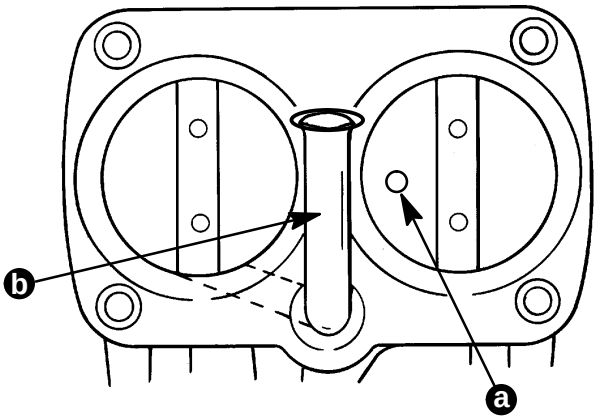
- Engine idle speed is a function of total air flow into the engine based on IAC valve pintle position.
- “Controlled” idle speed is programmed into the ECM, which determines the correct IAC valve pintle position to maintain the desired idle speed for all engine operating conditions and loads.
- The minimum idle air rate is set at the factory with stop screws. This setting allows enough air flow by the throttle valves to cause the IAC valve pintle to be positioned a calibrated number of steps (counts) from the seat during “controlled” idle operation.
- If the IAC valve is disconnected and reconnected with the engine running, the idle speed may be wrong. In this case, the IAC valve can be reset by doing the following: Turn off engine, wait ten seconds, and restart engine.

IAC Valve Air Flow Diagram





7.4L / 454 Throttle Body



454 / 502 Throttle Body

a - Air Hole
b - Air Tube (Models With VST)

72986

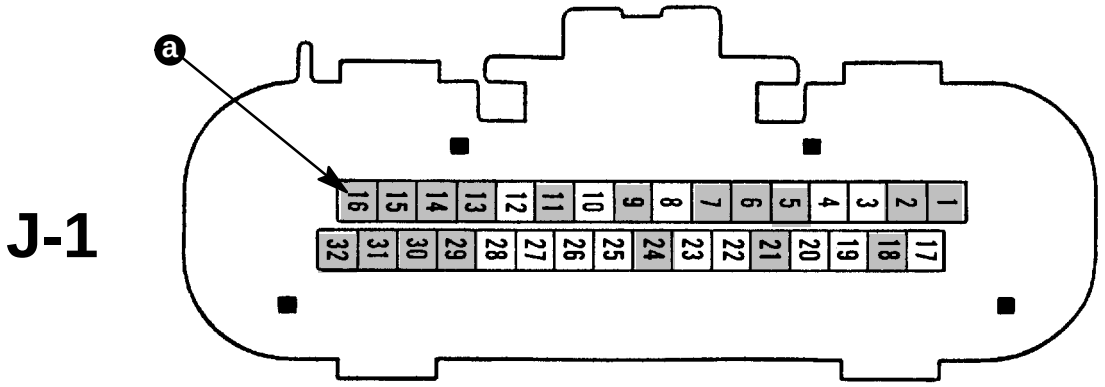
NOTE: *Not all 454 / 502 Magnums have the air hole located in the secondary throttle plate.*

ECM Connector and Symptom Charts

The following chart will aid in diagnosis of symptoms. These voltages were derived from a known good engine. The voltages shown were done with the electrical system intact and operational. These are voltage requirements to operate the different circuits.

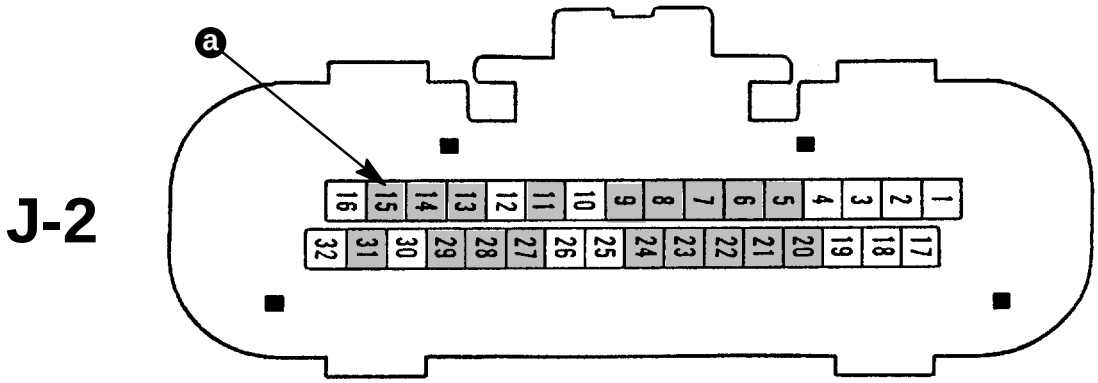
⚠CAUTION

Do not attempt to obtain these voltages by probing wires and connectors. Serious damage could result in loss of engine operation or wiring damage. Voltages can vary with battery conditions.



J-1

J-1 Front Pin 32 Pin Input Connector



J-2

J-2 Rear 32 Pin Output Connector
a - Shaded Area Denotes Pin Connector Location Used On Terminal

NOTE: *The Intake Air Temperature (IAT) Sensor [J1-24], Port Fuel Jumper J2-7 and J2-22] is not used on the 7.4L / 7.4LX Throttle Body Injection system*

IMPORTANT: The following conditions must be meet before testing.

1. Engine at operating temperature.
2. Ignition on or engine running.
3. Scan tool not connected.

THESE NOTES APPLY TO FOLLOWING ECM CONNECTOR AND SYMPTOM CHARTS.
The “B+” Symbol indicates a system voltage (battery).

NOTE 1: Battery voltage for first two seconds, then 0 volts.

NOTE 2: Varies with temperature.

NOTE 3: Varies with manifold vacuum.

NOTE 4: Varies with throttle movement.

NOTE 5: Less than .5 volt (500 mV).

NOTE 6: Dual or multiple engines must share a common ground (–) for proper serial data communications.

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ECM Connector and EFI Symptoms Chart (J-1 Circuits)

Pin	Pin Function	Circuit (CKT) Number (#)	Wire Color	Normal Voltage		Diagnostic Trouble Codes DTC(s)	Possible Symptoms
				Ignition ON	Engine Running		
J1-1	Knock Sensor Signal	485	BLK	9.5V	9.5V	43	Poor Fuel Economy, Poor Performance Detonation
J1-2	ECT Signal	410	YEL	1.95V (NOTE 2)	1.95V (NOTE 2)	14	Poor Performance, Exhaust Odor, Rough Idle RPM Reduction
J1-3	Not Used	–	–	–	–	–	–
J1-4	Not Used	–	–	–	–	–	–
J1-5	Master/ Slave	916	YEL	B+	B+	None	Lack Of Data From Other Engine (Dual Engine Only)
J1-6	Discrete Switch	931	BRN	–	–	None	Power Reduction Mode
J1-7	Diagnostic Test	451	WHT/ BLK	B+	B+	None	Incorrect Idle, Poor Performance
J1-8	Not Used	–	–	–	–	–	–
J1-9	Map Signal	432	LT GRN	4.9V	1.46V (NOTE 3)	33	Poor Performance, Surge, Poor Fuel Economy, Exhaust Odor
J1-10	TP Signal	417	DK BLU	.62V (NOTE 4)	.62V (NOTE 4)	21	Poor Performance And Acceleration, Incorrect Idle
J1-11	Ignition Fused	439	PNK/ BLK	B+	B+	None	No Start
J1-12	Not Used	–	–	–	–	–	–
J1-13	TP and IAT Ground	813	BLK	0 (NOTE 5)	0 (NOTE 5)	21,23	High Idle, Rough Idle, Poor Performance Exhaust Odor
J1-14	ECM Ground	450	BLK/ WHT	0 (NOTE 5)	0 (NOTE 5)	None	No Start
J1-15	TP 5V Reference	416	GRY	5V	5V	21	Lack Of Power, Idle High
J1-16	Battery	440	ORN	B+	B+	None	No Start

See Page 5C-29 For NOTES

ECM Connector and EFI Symptoms Chart (J-1 Circuits)

Pin	Pin Function	Circuit (CKT) Number (#)	Wire Color	Normal Voltage		Diagnostic Trouble Codes DTC(s)	Possible Symptoms
				Ignition ON	Engine Running		
J1-17	Not Used	–	–	–	–	–	–
J1-18	Serial Data	461	ORN/ BLK	5V	5V	None	No Serial Data (NOTE 6)
J1-19	Not Used	–	–	–	–	–	–
J1-20	Not Used	–	–	–	–	–	–
J1-21	Lanyard Stop Switch	942	PNK	0	0	NONE	No Start
J1-22	Not Used	–	–	–	–	–	–
J1-23	Not Used	–	–	–	–	–	–
J1-24	IAT Sensor	472	TAN	5V	(NOTE 2)	23	Poor Fuel Economy, Exhaust Odor
J1-25	Not Used	–	–	–	–	–	–
J1-26	Not Used	–	–	–	–	–	–
J1-27	Not Used	–	–	–	–	–	–
J1-28	Not Used	–	–	–	–	–	–
J1-29	MAP Ground	814	BLK	0 (NOTE 5)	0 (NOTE 5)	33	Lack Of Performance,Exhaust Odor, Stall
J1-30	ECM Ground	450	BLK/ WHT	0 (NOTE 5)	0 (NOTE 5)	None	No Start
J1-31	MAP 5V Reference	416	GRY	5V	5V	33	Lack Of Power, Surge, Rough Idle, Exhaust Odor
J1-32	Battery	440	ORN	B+	B+	None	No Start

NOTE: *The Intake Air Temperature (IAT) Sensor [J1-24] is not used on the 7.4L / 7.4LX Throttle Body Injection system. J1-21 is not used on 1997 and newer models.*

See page 5C-29 for NOTES

ECM Connector and EFI Symptoms Chart (J-2 Circuits)

Pin	Pin Function	Circuit (CKT) Number (#)	Wire Color	Normal Voltage		Diagnostic Trouble Codes DTC(s)	Possible Symptoms
				Ignition ON	Engine Running		
J2-1	Not Used	–	–	–	–	–	–
J2-2	Not Used	–	–	–	–	–	–
J2-3	Not Used	–	–	–	–	–	–
J2-4	Not Used	–	–	–	–	–	–
J2-5	Injector Driver	468	LT GRN	B+	B+	None	Rough Idle, Lack Of Power, Stall
J2-6	Ignition Control Ref. Low	463	BLK/ RED	0 (NOTE 5)	0 (NOTE 5)	None	Poor Performance
J2-7	Port Fuel Jumper	901	WHT	–	–	None	–
J2-8	Ignition Control Ref. High	430	PUR/ WHT	5V	1.6V	None	No Restart
J2-9	Fuel Pump Relay Driver	465	DK GRN/ WHT	0 (NOTE 1&5)	B+	None	No Start
J2-10	Not Used	–	–	–	–	–	–
J2-11	Coolant Over temp.	112	DK GRN	0	0	NONE	Power Reduction Mode or Improper Audio Warning
J2-12	Not Used	–	–	–	–	–	–
J2-13	IAC “A” Low	442	BLU/ BLK	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J2-14	IAC “B” Low	443	GRN/ WHT	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J2-15	Injector Ground	450	BLK/ WHT	0 (NOTE 5)	0 (NOTE 5)	None	Rough Running, Lack Of Power, Poor Performance
J2-16	Not Used	–	–	–	–	–	–

NOTE: *J2-7 is not used on the 7.4L / 7.4LX Throttle Body Injection system.*

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ECM Connector and EFI Symptoms Chart (J-2 Circuits)

Pin	Pin Function	Circuit (CKT) Number (#)	Wire Color	Normal Voltage		Diagnostic Trouble Codes DTC(s)	Possible Symptoms
				Ignition ON	Engine Running		
J2-17	Not Used	–	–	–	–	–	–
J2-18	Not Used	–	–	–	–	–	–
J2-19	Not Used	–	–	–	–	–	–
J2-20	Fuel Injector Ground	450	BLK/ WHT	0 (NOTE 5)	0 (NOTE 5)	None	Rough Running, Poor Idle, Lack Of Performance
J2-21	Injector Driver	467	DK BLU	B+	B+	None	Rough Idle, Lack Of Power, Stalling
J2-22	Port Fuel Jumper	901	WHT	–	–	–	–
J2-23	Ignition Control Signal	423	WHT	0 (NOTE 5)	1.2V	42	Stall, Will Restart In Bypass Mode, Lack Of Power
J2-24	Ignition Control Bypass	424	TAN/ BLK	0 (NOTE 5)	4.5V	42	Lack Of Power, Fixed Timing
J2-25	Not Used	–	–	–	–	–	–
J2-26	Not Used	–	–	–	–	–	–
J2-27	Discrete Switch Signal	31	TAN	–	–	–	Audio Warning System Activated
J2-28	IAC “A” High	441	BLU/ WHT	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J2-29	IAC “B” Low	444	GRN/ BLK	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J2-30	Not Used	–	–	–	–	–	–
J2-31	MIL Lamp	419	BRN/ WHT	0 (NOTE 5)	0 (NOTE 5)	None	Lamp Inoperative
J2-32	Not Used	–	–	–	–	–	–

NOTE: *J2-22 is not used on the 7.4L / 7.4LX Throttle Body Injection system*

See page 5C-29 for NOTES

Multi Port Injector Balance Test

(Refer to the following figure for test set-up.)

The injector balance tester is a tool used to turn the injector ON for a precise amount of time, thus spraying a measured amount of fuel into the manifold. This causes a drop in fuel rail pressure that we can record and compare between each injector. All injectors should have the same amount of pressure drop. Any injector with a pressure drop that is 1.5 PSI (or more) greater or less than the average drop of the other injectors should be considered faulty and replaced. Injector testers are available for various manufacturers. For 7.4L / 454 and 502 engines: the tester must be capable of selecting an injector pulse width in the range of 200-400 milliseconds (m sec). The recommended starting point for these engines is approximately 300 m sec. In any case a pulse width that drops the fuel rail pressure to half the normal operating pressure, should be used.

STEP 1

Engine cool down period (ten minutes) is necessary to avoid irregular readings due to “hot soak” fuel boiling. Relieve fuel pressure in the fuel rail as outlined in “Fuel Pressure Relief Procedure” in “Repair Procedures.” Remove plenum as outlined in “Repair Procedures.” With ignition OFF, connect fuel pressure gauge to fuel pressure tap.

Disconnect harness connectors at all injectors, and connect injector tester to one injector. Use adaptor harness furnished with injector tester to energize injectors. Follow manufacturer’s instructions for use of adaptor harness. Ignition must be OFF at least ten seconds to complete ECM shutdown cycle. Fuel pump should run about two seconds after ignition is turned ON.

At this point, insert clear tubing attached to vent valve into a suitable container and bleed air from gauge and hose to ensure accurate gauge operation. Repeat this step until all air is bled from gauge.

STEP 2

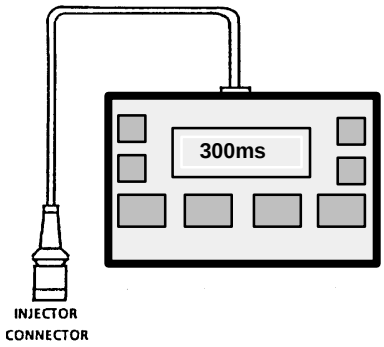
Turn ignition OFF for ten seconds and then ON again several times to get fuel pressure to its maximum. Record this initial pressure reading. Energize tester one time and note pressure drop at its lowest point. (Disregard any slight pressure increase after drop hits low point.) By subtracting this second pressure reading from the initial pressure, we have the actual amount of injector pressure drop.

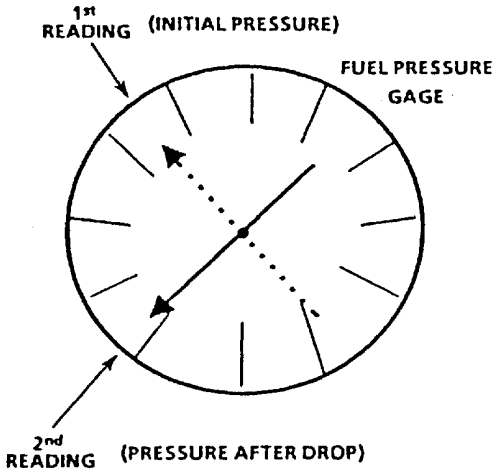
STEP 3

Repeat Step 2 on each injector and compare the amount of drop. Usually, good injectors will have virtually the same drop. Retest any injector that has a pressure difference of 1.5 PSI (10 kPa), either more or less than the average of the other injectors on the engine. Replace any injector that also fails the retest. If the pressure drop of all injectors is within 1.5 PSI (10 kPa) of this average, the injectors appear to be flowing properly. Reconnect them and review “Troubleshooting.”

NOTE: *The entire test should not be repeated more than once without running the engine to prevent flooding. (This includes any retest on faulty injectors.)*

Fuel Injector Balance Test Set-up (Multi-Port Injection)

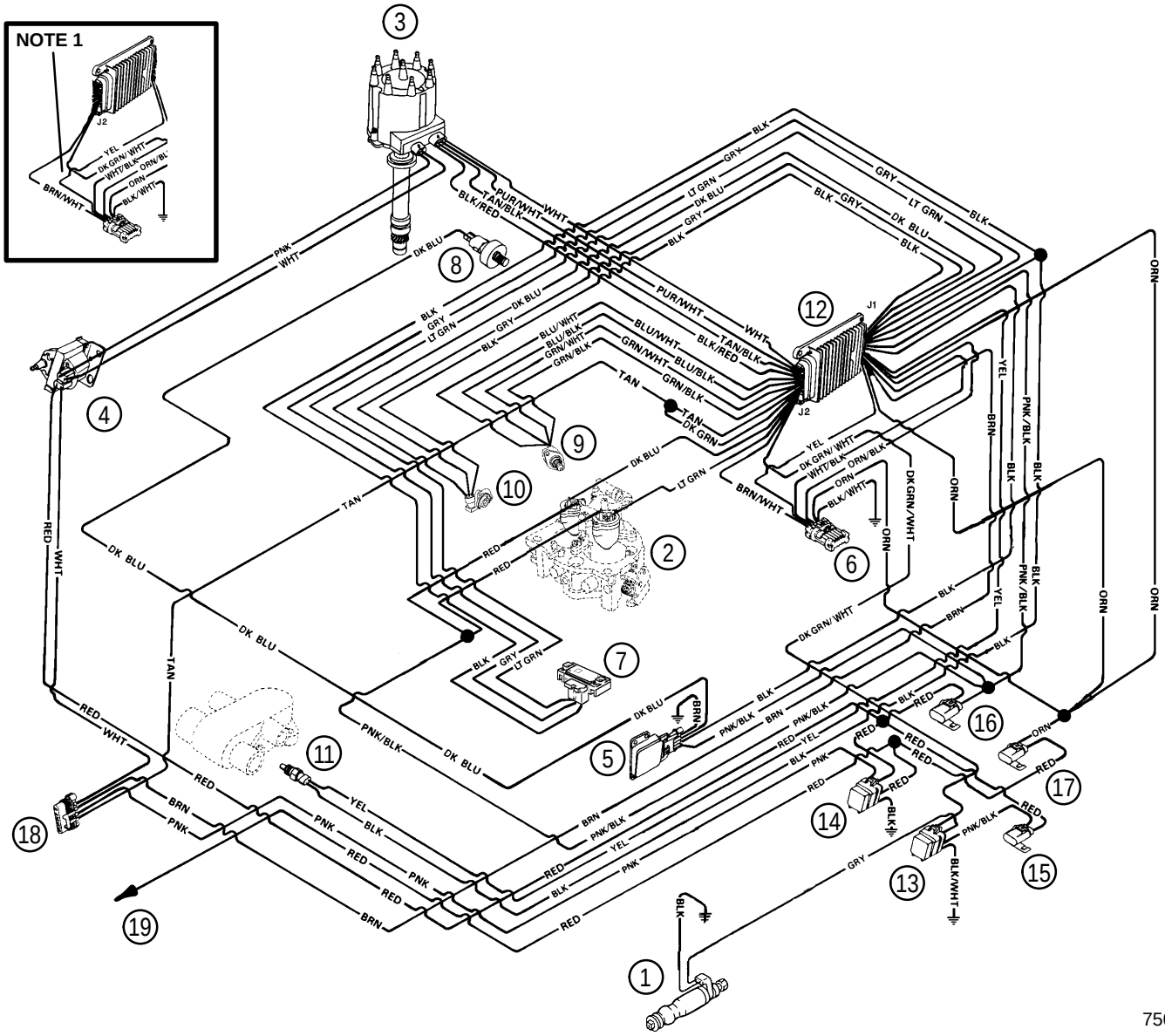




EXAMPLE								
Cylinder	1	2	3	4	5	6	7	8
1st. Reading	38 PSI (262 kPa)	38 PSI (262 kPa)	38 PSI (262 kPa)	38 PSI (262 kPa)	38 PSI (262 kPa)	38 PSI (262 kPa)	38 PSI (262 kPa)	38 PSI (262 kPa)
2nd Reading	19 PSI (131 kPa)	17 PSI (117 kPa)	21 PSI (145 kPa)	19 PSI (131 kPa)	19 PSI (131 kPa)	19 PSI (131 kPa)	19 PSI (131 kPa)	19 PSI (131 kPa)
Amount of Drop	19 PSI (131 kPa)	21 PSI (145 kPa)	17 PSI (117 kPa)	19 PSI (131 kPa)	19 PSI (131 kPa)	19 PSI (131 kPa)	19 PSI (131 kPa)	19 PSI (131 kPa)
	OK	Rich (Too Much Fuel Drop)	Lean (Too Little Fuel Drop)	OK	OK	OK	OK	OK

Wiring Harness Diagrams

MCM 7.4LX / MIE 7.4L Throttle Body Injection Bluewater Inboard



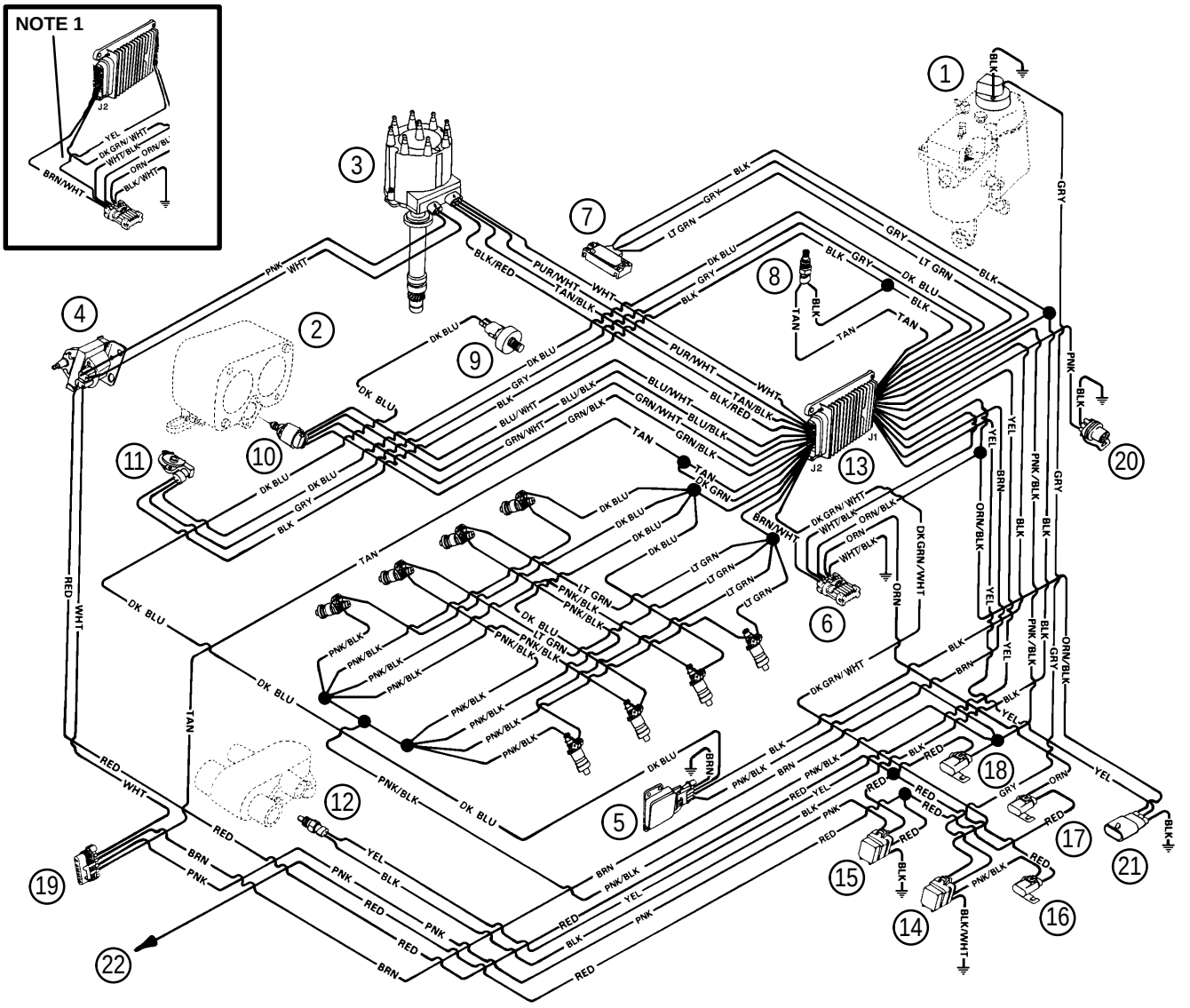
Note: All BLACK wires with a ground symbol are interconnected within the fuel injection system harness.

NOTE 1: As a mid year (1996-1/2) model change, the Throttle Body Injection models have the lanyard stop connector removed from the wiring harness. The dual engine capability is relocated by routing the YEL wire to the Data Link Connector (DLC).

Index

1 -Fuel Pump
2 -Throttle Body
3 -Distributor
4 -Coil
5 -Electronic Spark Control (KS) Module
6 -Data Link Connector (DLC)
7 -Manifold Absolute Pressure (MAP) Sensor
8 -Knock Sensor
9 -Idle Air Control (IAC)
10-Throttle Position (TP) Sensor
11-Engine Coolant Temperature (ECT) Sensor
12-Electronic Control Module (ECM)
13-Fuel Pump Relay
14-Ignition/System Relay
15-Fuse (15 Amp) Fuel Pump
16-Fuse (15 Amp) ECM/DLC/Battery
17-Fuse (10 Amp) ECM/Injector/Ignition/Knock Module
18-Harness Connector To Starting/Charging Harness
19-Positive (+) Power Wire To Engine Circuit Breaker

MCM 7.4LX Multi-Port Injection / 454 / 502 Magnum Multi-Port Injection / MIE 454 Tournament Ski Multi-Port Injection / 502 Magnum Multi-Port Injection



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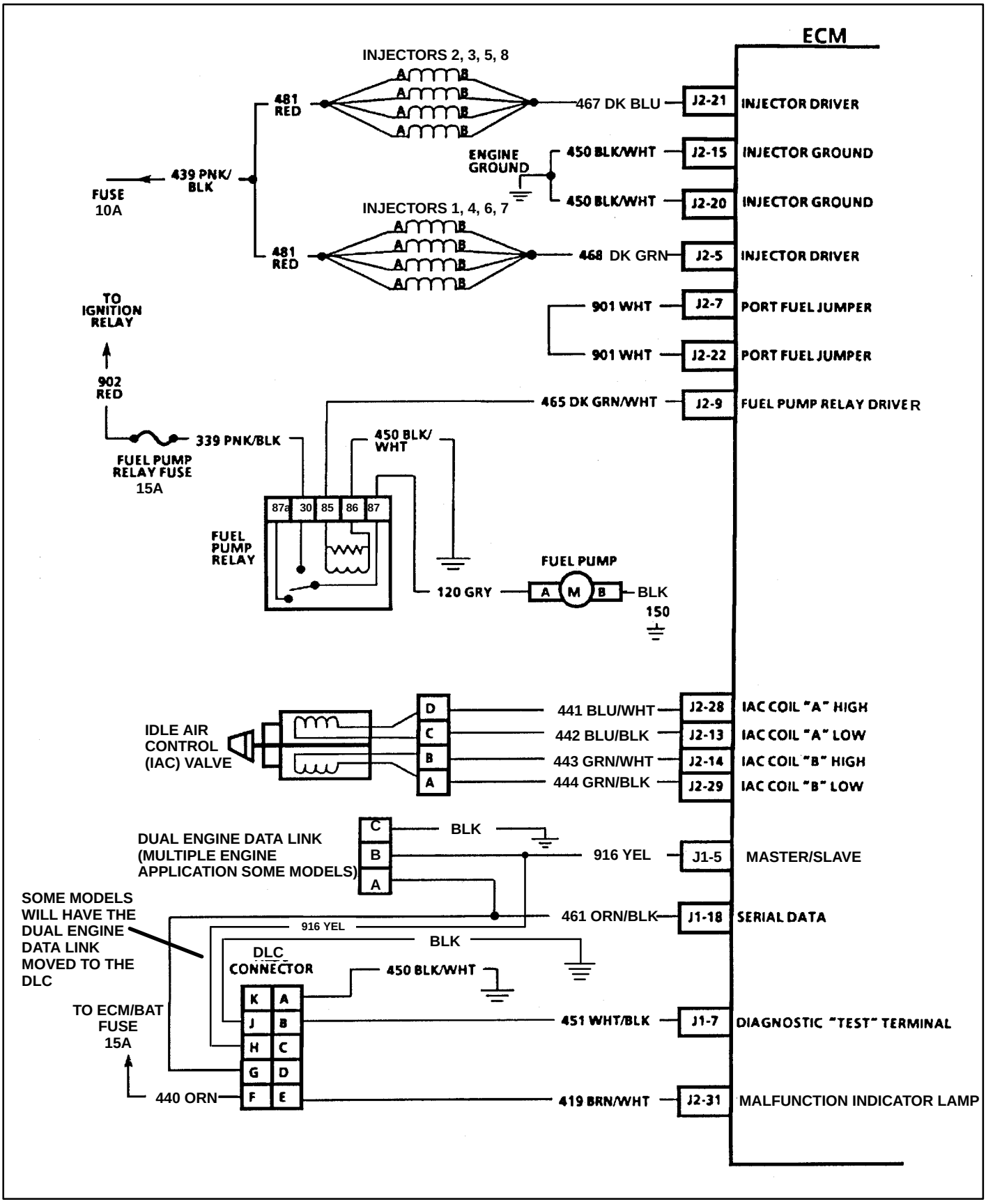
NOTE: All BLACK wires with a ground symbol are interconnected within the fuel injection system harness.

NOTE 1: As a mid year (1996-1/2) model change, the Multi Port Injection models have the lanyard stop connector removed from the wiring harness. The dual engine capability is relocated by routing the YEL wire to the Data Link Connector (DLC).

Index

1 -Vapor Separator Tank (VST)
2 -Throttle Body
3 -Distributor
4 -Coil
5 -Knock Sensor (KS) Module
6 -Data Link Connector (DLC)
7 -Manifold Absolute Pressure (MAP) Sensor
8 -Intake Air Temperature (IAT) Sensor
9 -Knock Sensor
10-Idle Air Control (IAC)
11-Throttle Position (TP) Sensor
12-Engine Coolant Temperature (ECT) Sensor
13-Electronic Control Module (ECM)
14-Fuel Pump Relay
15-Ignition Relay
16-Fuel Pump Fuse (15 Amp)
17-Injector Fuse (15 Amp) ECM, DLC, Battery
18-ECM Fuse (10 Amp) ECM/Ignition/Injector/ Knock Sensor Module
19-Harness Connector to Starting/Charging Harness
20-Harness Connector to Lanyard Stop Switch (Optional)
21-Harness Connector for Dual Engine Data Link Cable (1996-1/2 And Earlier Models)
22-Positive (+) Power Wire to Engine Circuit Breaker

Multi-Port Injection Wiring Diagram (Chart 1 Of 4)



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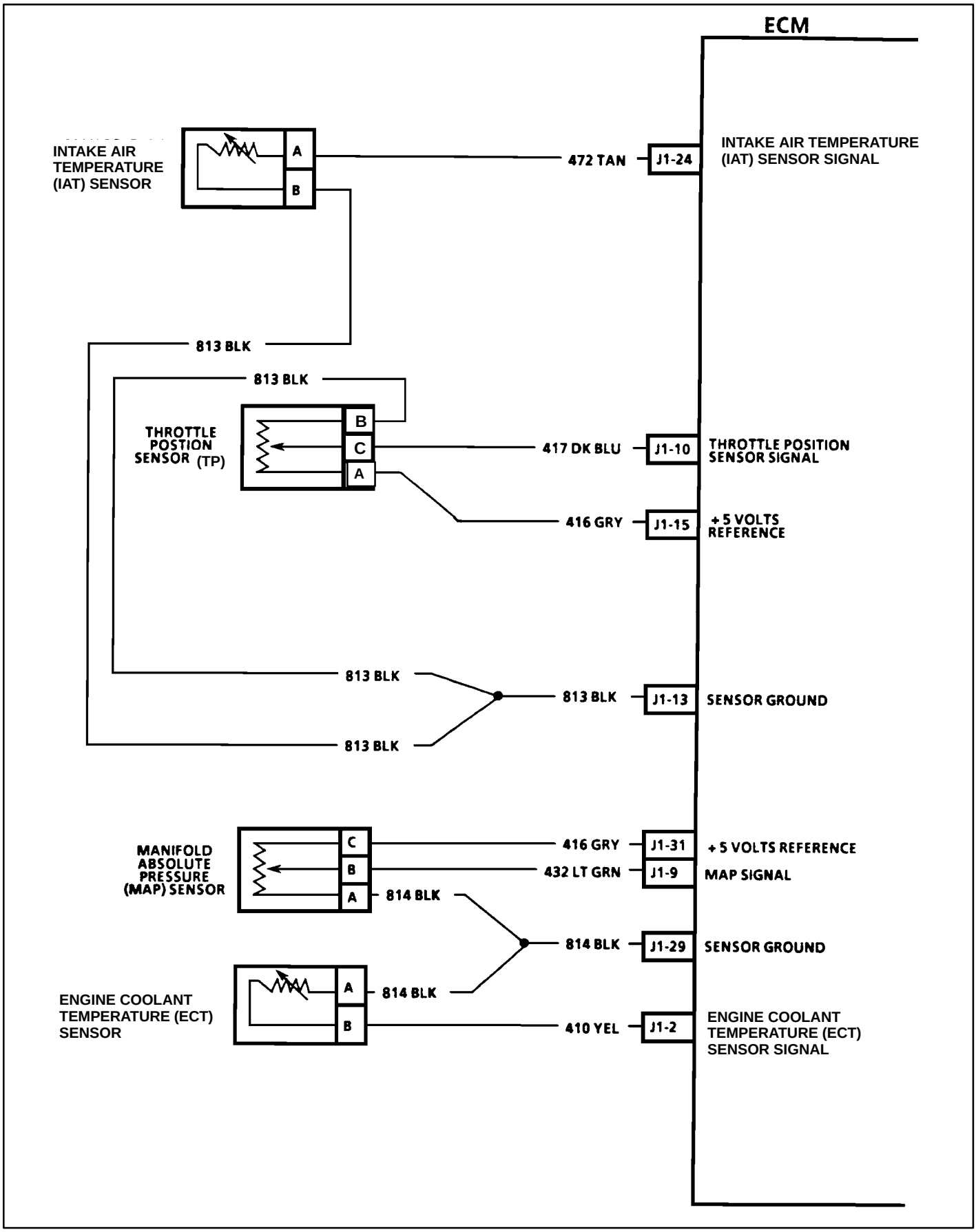
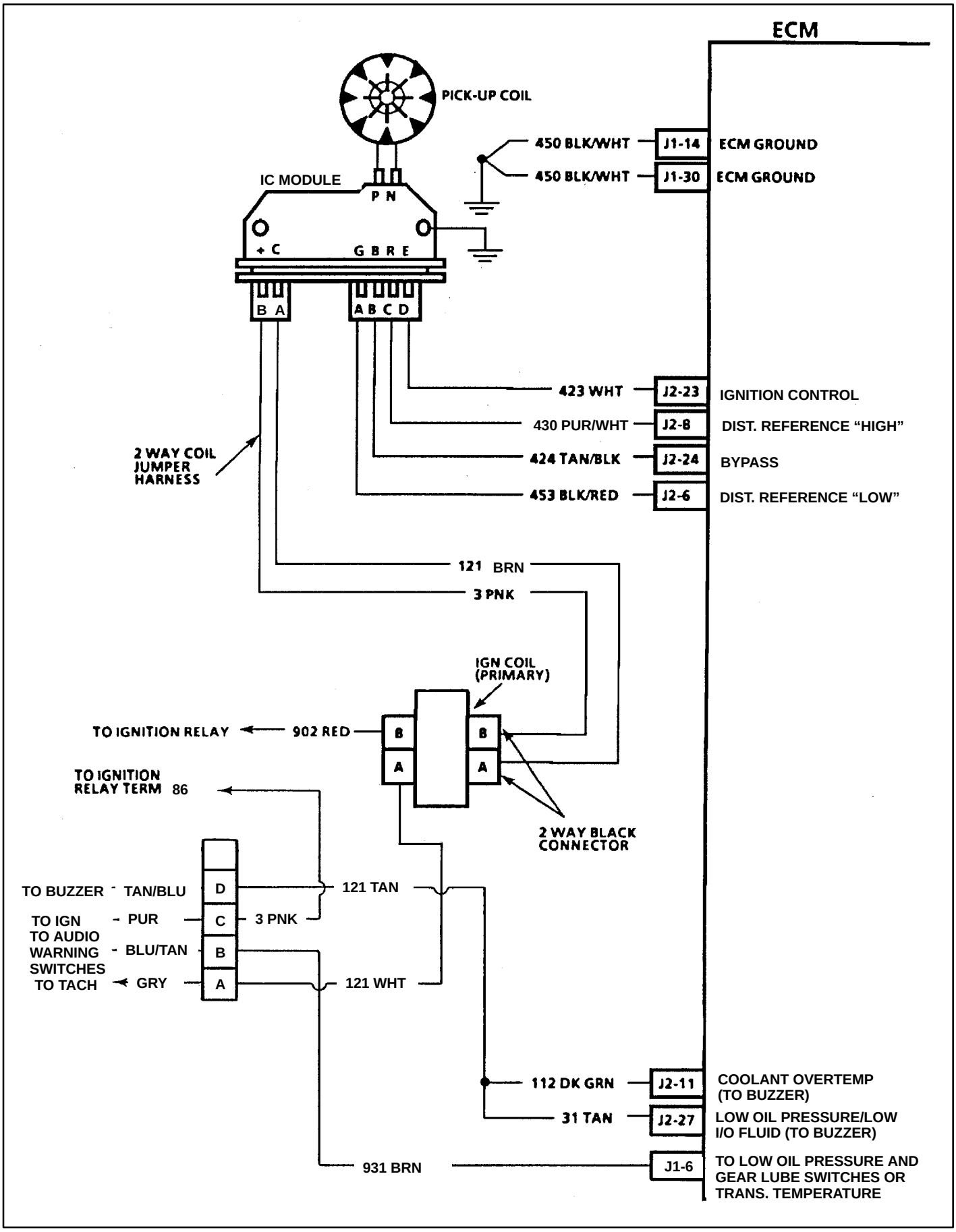
Multi-Port Injection Wiring Diagram (Chart 2 Of 4)



Multi-Port Injection Wiring Diagram (Chart 3 Of 4)



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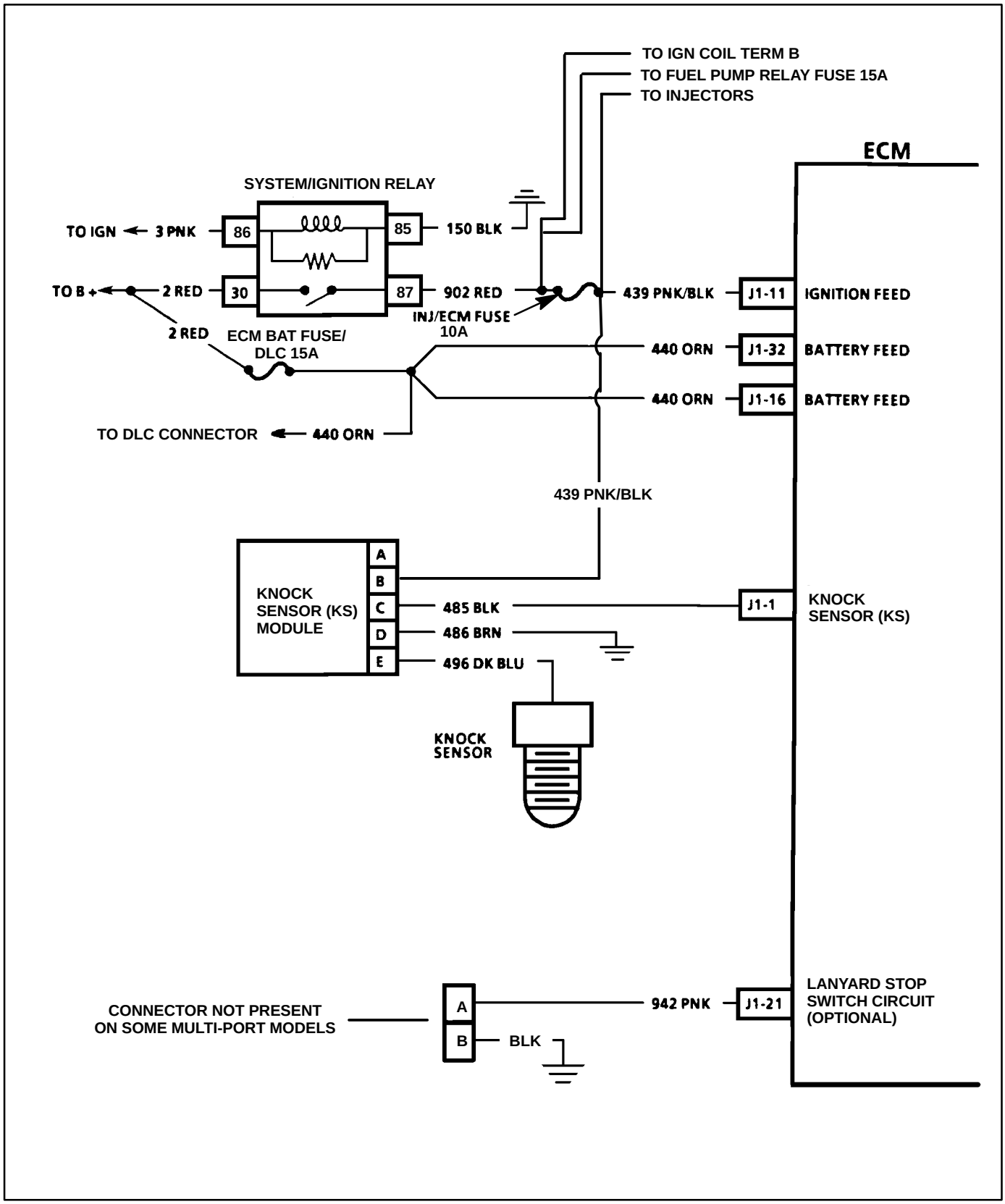
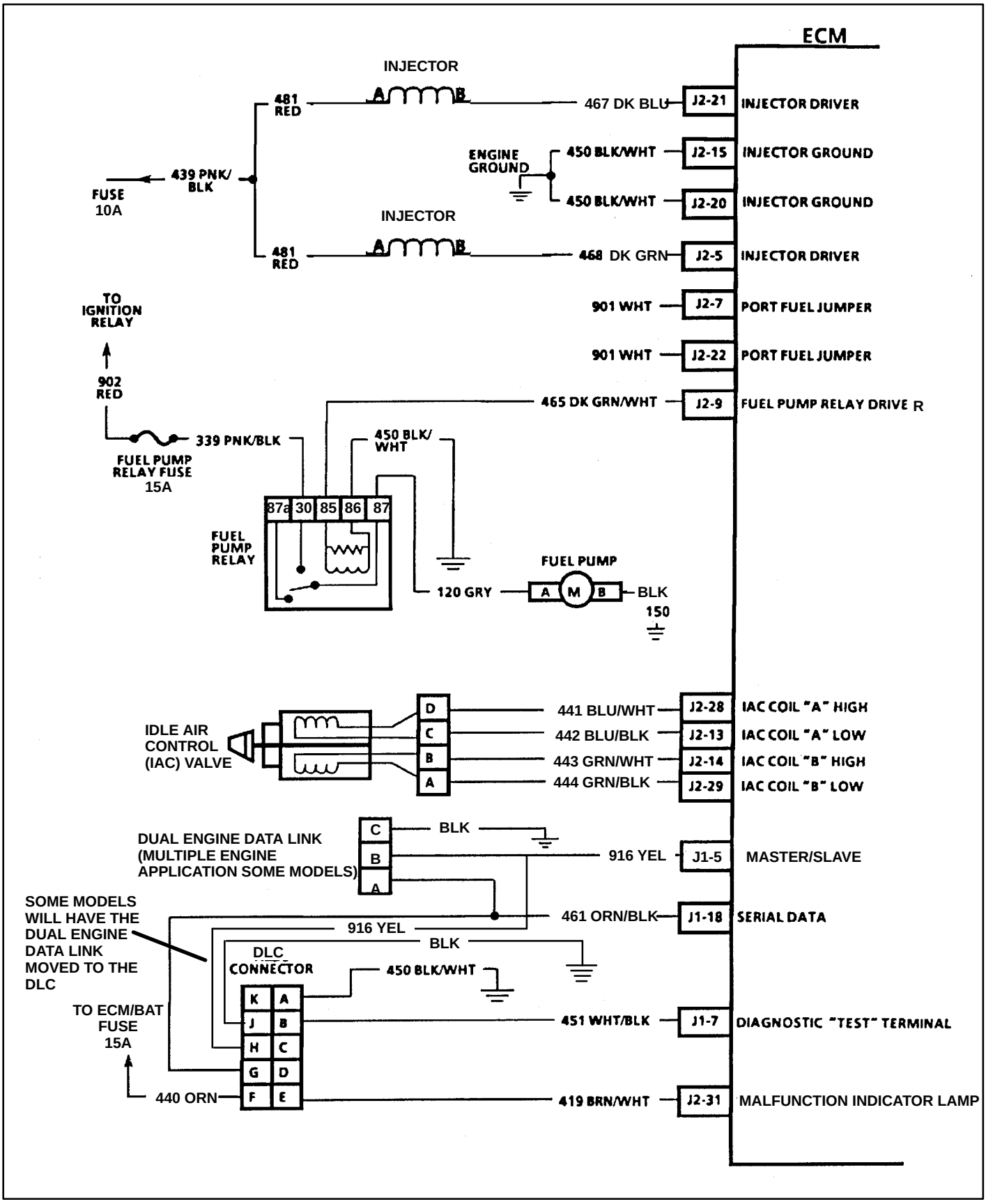
Multi-Port Injection Wiring Diagram (Chart 4 Of 4)



Throttle Body Injection Wiring Diagram (Chart 1 of 4)



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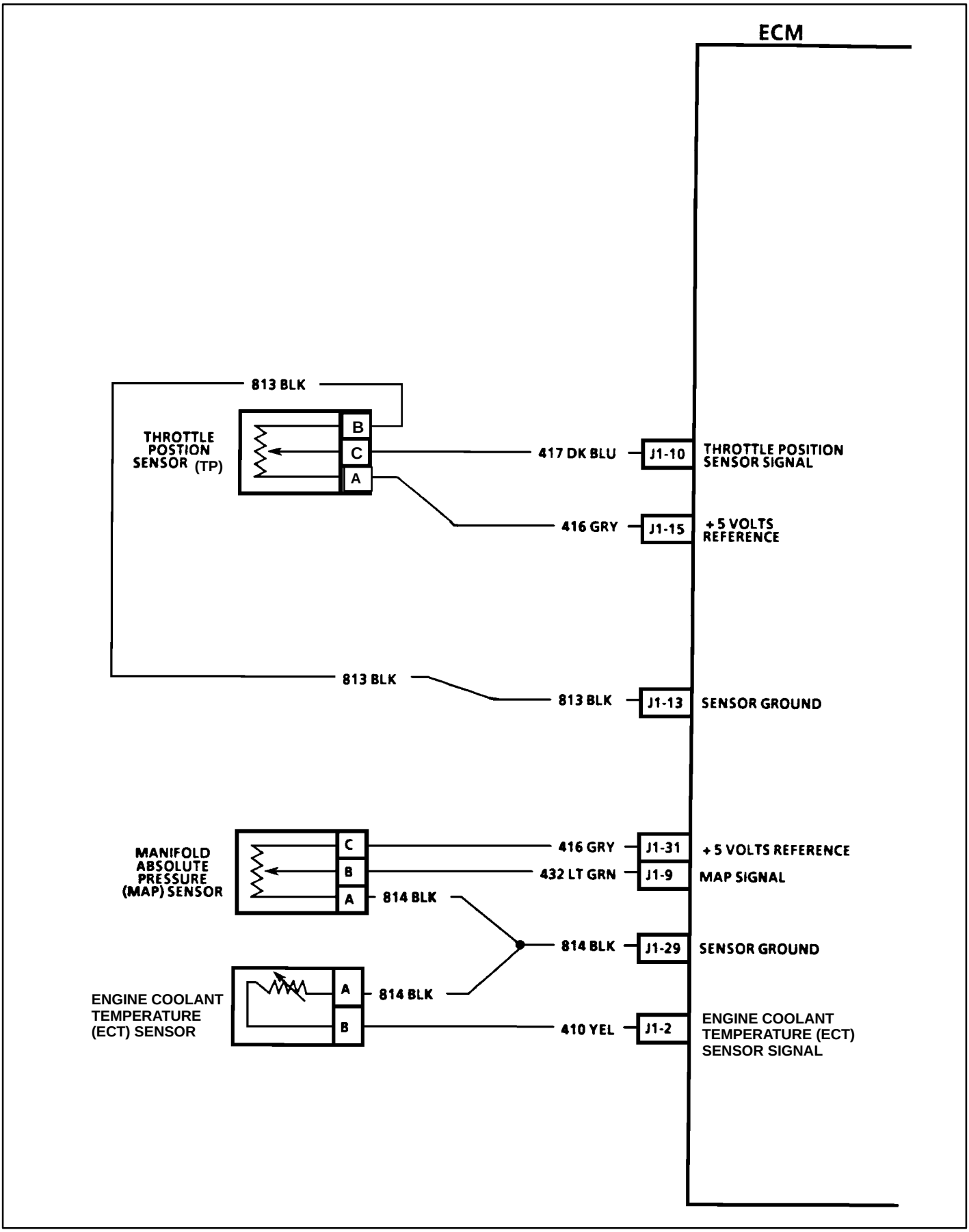
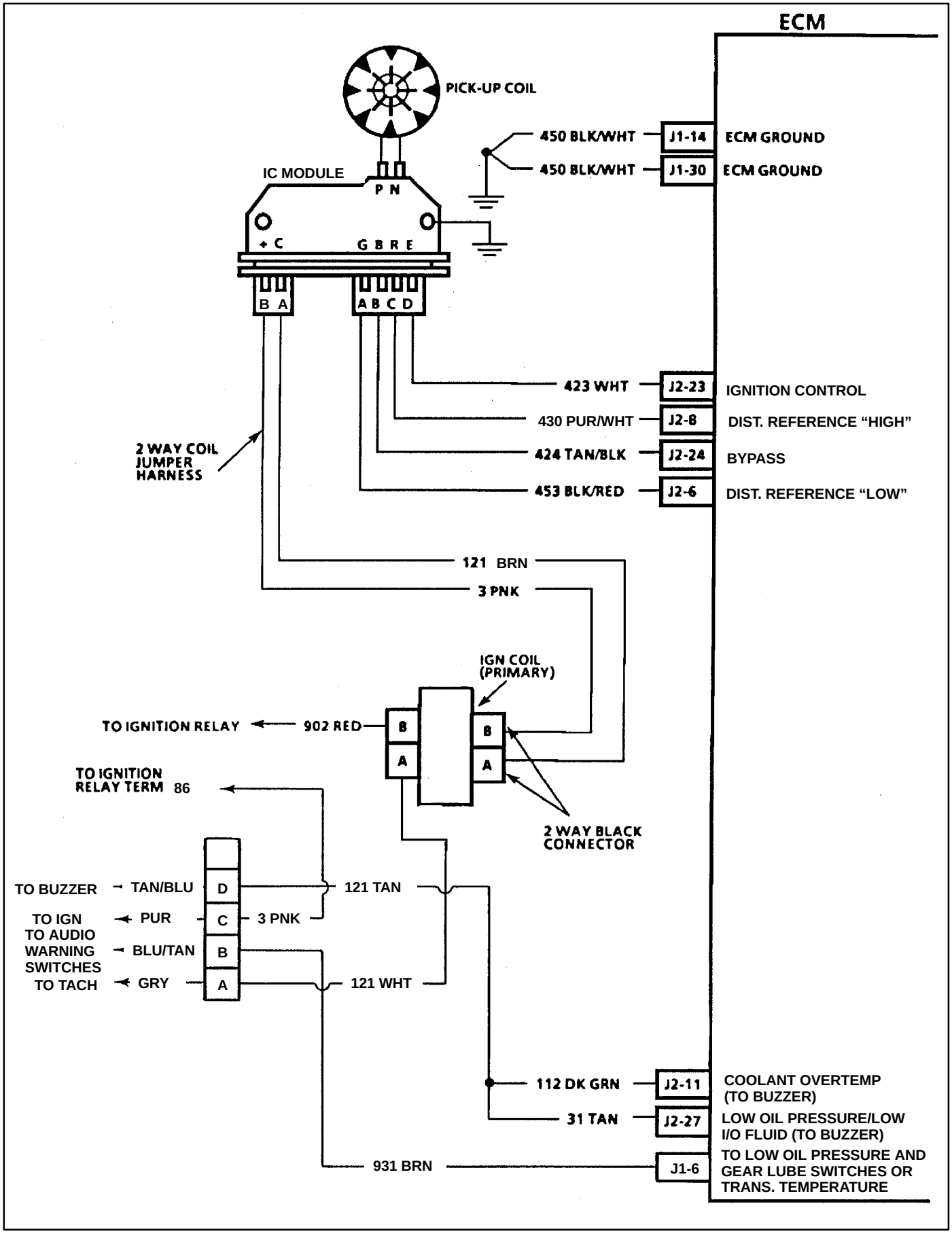
Throttle Body Injection Wiring Diagram (Chart 2 Of 4)



Throttle Body Injection Wiring Diagram (Chart 3 Of 4)



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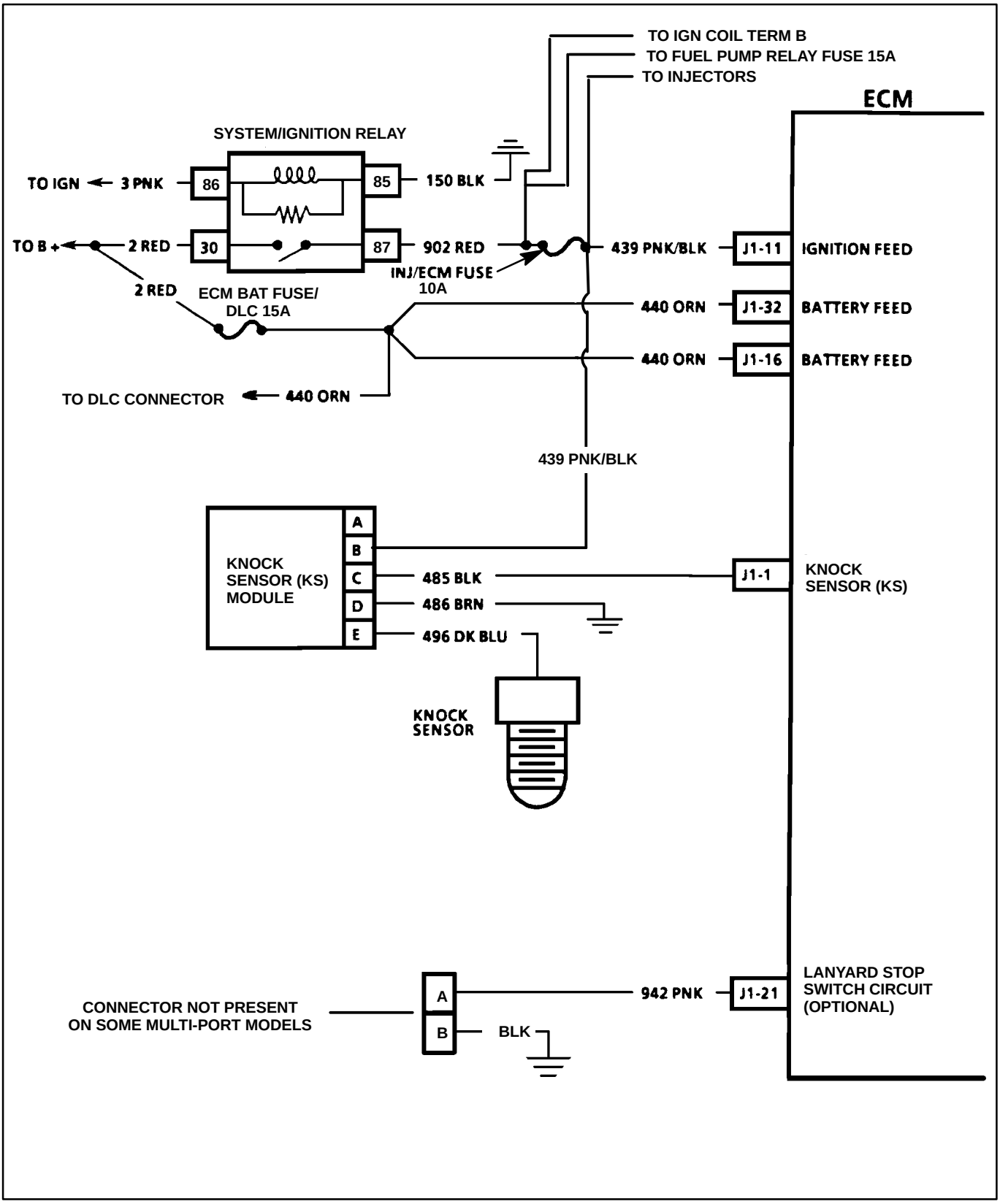
Throttle Body Injection Wiring Diagram (Chart 4 Of 4)



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Diagnostic Circuit Check

The Diagnostic Circuit Check is an organized approach to identifying a problem created by an electronic engine control system malfunction. It must be the starting point for any driveability complaint diagnosis because it directs the service technician to the next logical step in diagnosing the complaint.

NOTE: *A scan tool that displays faulty data should not be used, and the problem should be reported to the manufacturer. The use of a faulty scan tool can result in misdiagnosis and unnecessary parts replacement.*

The scan tool data listed in the table may be used for comparison. After completing the diagnostic circuit check and finding the on-board diagnostics functioning properly and no trouble codes displayed. The "Typical Data Values" are an average of display values recorded from normally operating vessels and are intended to represent what a normally functioning system would typically display.

Only the parameters listed below are used in this manual for diagnosing. If a scan reads other parameters, the values are not recommended for use in diagnosing. If all values are within the range illustrated, refer to "Troubleshooting."

Scan Tool Normal Specifications
(Idle / Warm Engine / Closed Throttle / Neutral)

Scan Position	Units Displayed	Typical Data Value
RPM	RPM	600-700 RPM
Desired RPM	RPM	600 RPM
Coolant Temp.	° F(° C)	150-170° F (66-77° C)
Manifold Air Temp.	° F (° C)	Varies with Ambient Temperature
Throttle Position	Volts	.4 to .8 Volts
Throttle Angle	0-100 %	0-1%
MAP	Volts or kPa	1-3 Volts or (45-55 kPa) (Depends on Vacuum and Baro Pressure)
Baro	Volts or kPa	3-5 Volts (Depends on Altitude and Barometric Pressure)
Bat	Volts	12.0-14.5 Volts
Spark Advance	Degrees	-10 to 30°
Knock Retard	Degrees	0°
Idle Air Control IAC	Counts (Steps)	0-40 Counts
Minimum IAC Position	Counts (Steps)	0-40 Counts
Idle Air Control Follower	Counts (Steps)	0 Counts
Injector Pulse Width	msec.	2-3 msec.
Injector On Time Cranking	msec.	2.5–3.5 msec. (Depends on Water/Air Temperature)
Fuel Consumption	GPH (L/h)	1-2 GPH(3.7-7.5 L/h)
Time From Start	0:00:00-1092:00	Varies
Memory Calibration Check Sum	Calibration and Check Sum	Varies with Software revision in ECM
Oil Press/IO Level (See Note)	OK/LO	OK
Engine Overtemp	OK/Overheating	OK
Power Reduction Mode	OFF/ON	OFF
Lanyard Stop Mode	OFF/ON	OFF

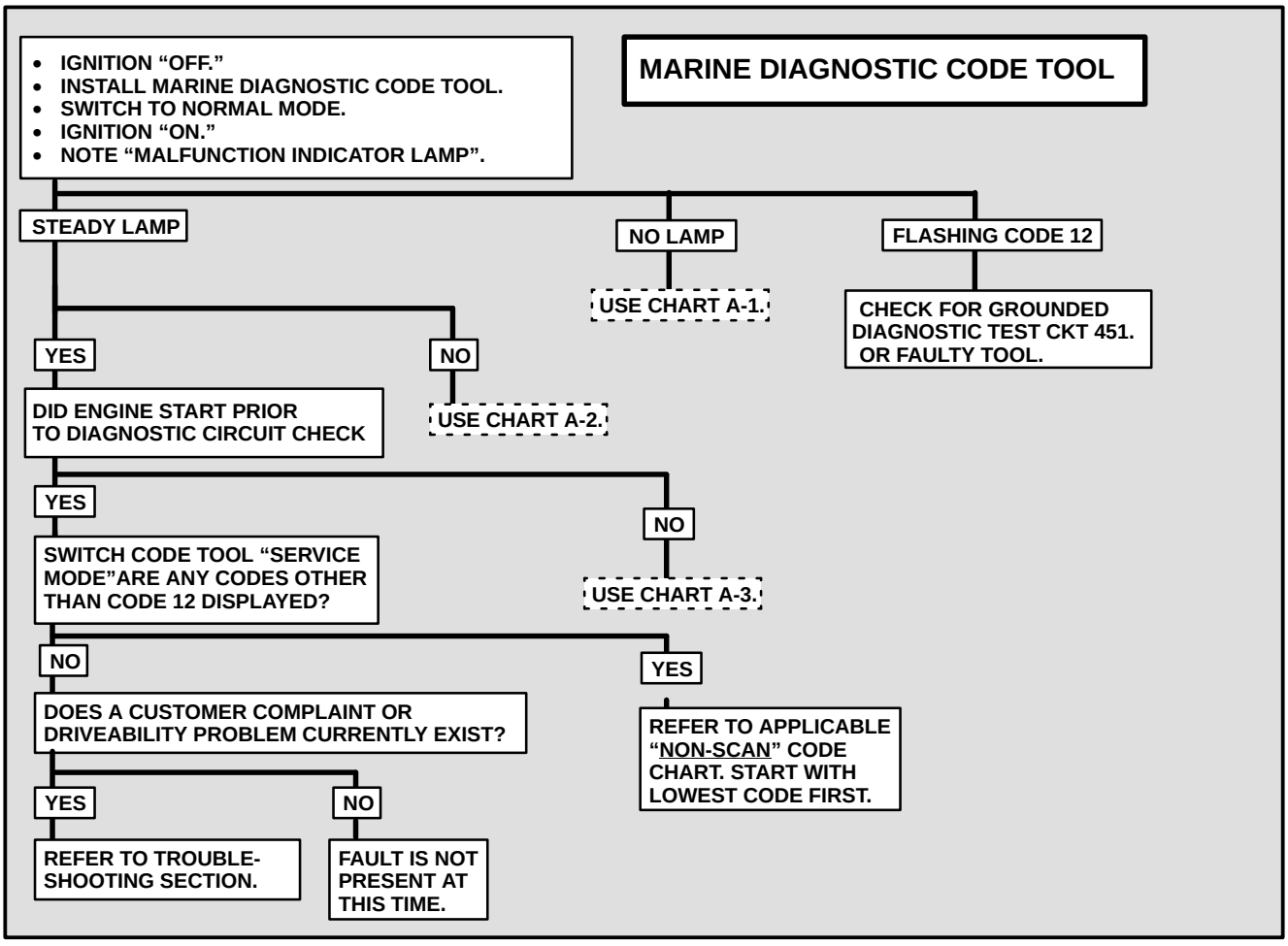
NOTE: MCM will read I/O Level and MIE will read Trans.

CLEARING CODES USING DIAGNOSTIC CODE TOOL (NON-SCAN)

1. Install diagnostic code tool.
2. Turn key ON.
3. Select service mode on code tool.
4. To clear codes, move the throttle, while in neutral, from 0% to 100% then back to 0%.
5. Exit “Service Mode” on code tool.
6. Start engine and let run for fifteen seconds.
7. Turn key OFF for 5 seconds.
8. Select “Service Mode” on code tool.
9. Turn key ON and read codes. If codes are still present, check note following and repeat from Step 1.
10. Refer to appropriate Troubleshooting and/or Diagnostic Charts

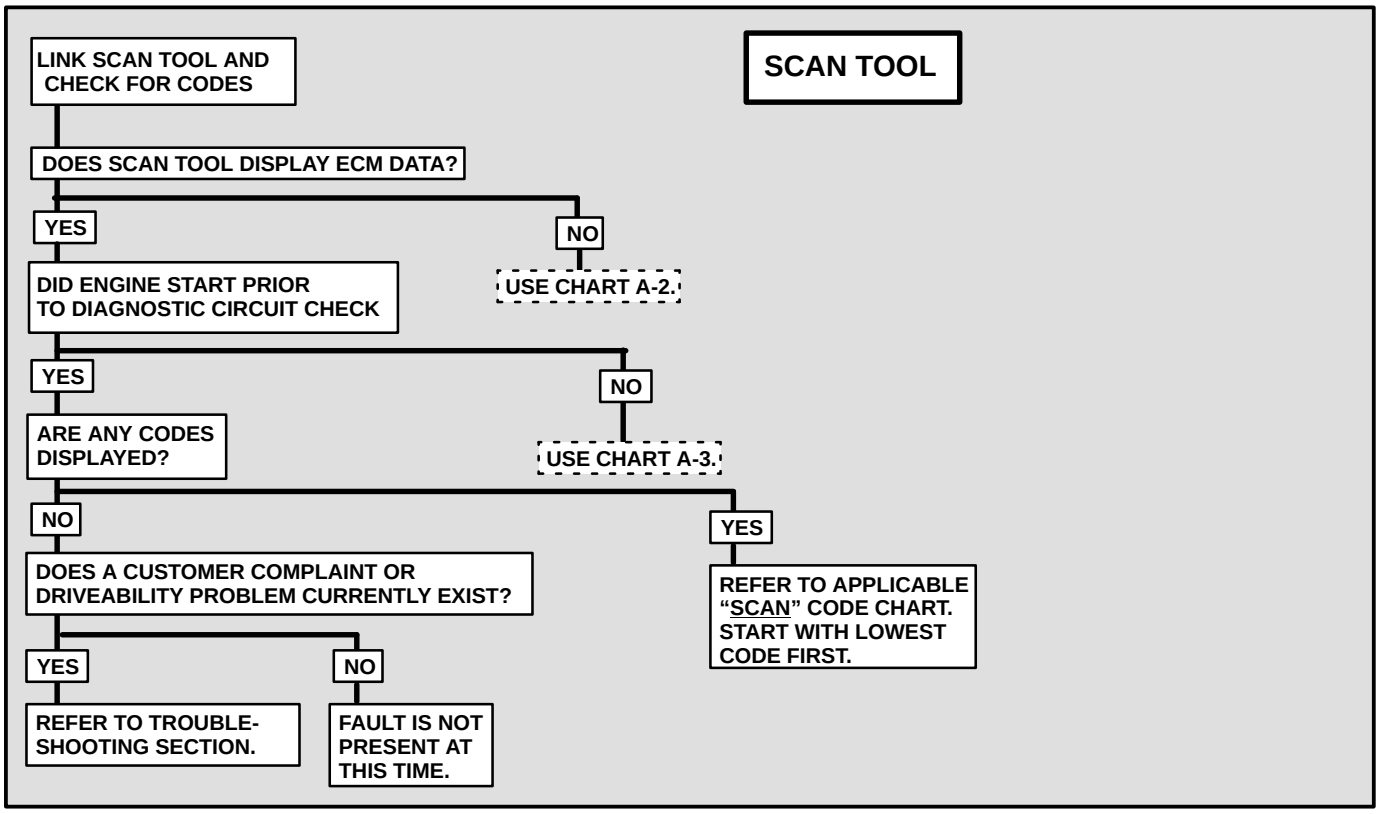
NOTE: *When clearing codes without the use of a scan tool, the battery must be fully charged and cranking speed must be at least 300 RPM. The ability to clear codes is directly dependent on the battery being fully charged and able to start the engine with adequate cranking RPM.*

A poorly charged battery or engine cranking problem may result in an ECM “reset” and may not allow stored trouble codes to be cleared from EEPROM memory. If this condition exists, BE SURE the battery is fully charged. If a low battery condition does exists the audio warning buzzer will come on for 2 seconds after engine start-up.

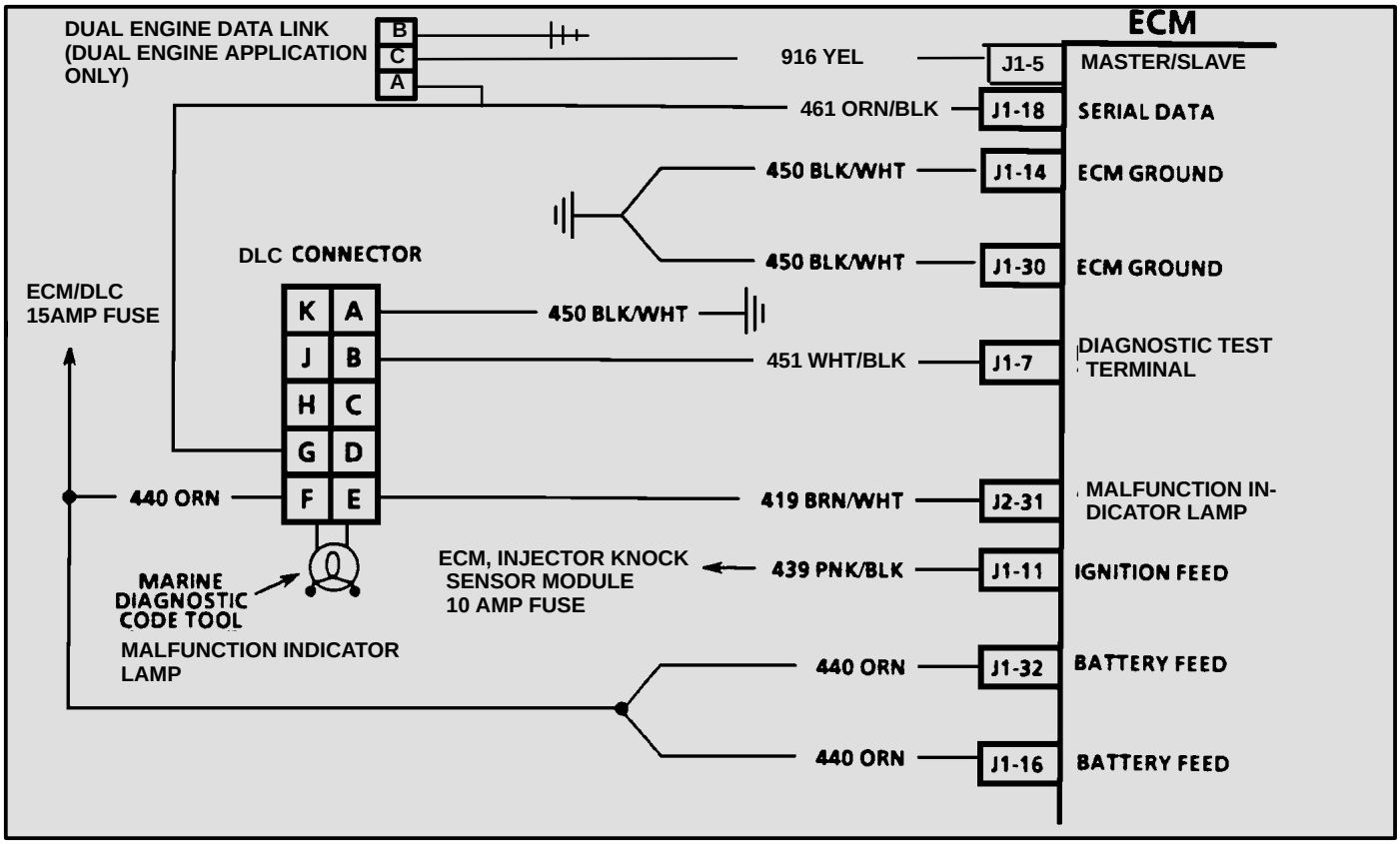


CLEARING CODES USING SCAN TOOL (SCAN)

1. Connect scan tool.
2. Start engine.
3. Select clear codes function.
4. Clear codes.
5. Turn key OFF.
6. Turn key ON and read codes. If codes are still present, (there is a real fault in system) check note preceding and repeat Step 1.



No “Malfunction Indicator Lamp” (Marine Diagnostic Code Tool Installed)
Chart A-1 (1 of 2)



CIRCUIT DESCRIPTION:

There should always be a steady “Malfunction Indicator Lamp” when the ignition is ON and engine stopped. Ignition voltage is supplied directly to the light bulb. The Electronic Control Module (ECM) will control the light and turn it ON by providing a ground path through CKT 419 to the ECM.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step insures that battery voltage is available to terminal “F” of the DLC connector.
2. This step checks for ground present in DLC connector terminal “E.” This indicates that the ECM is capable of completing the ground to the “Malfunction Indicator Lamp”.
3. This step isolates the cause of incomplete ground to either a wiring or ECM circuitry.
4. If the engine fails to crank, this may indicate a failure in the starting system circuit.

DIAGNOSTIC AIDS:

Engine runs OK, check:

- Faulty light bulb.
- CKT 419 open.

Engine cranks but will not run, check:

- Continuous battery - 50 amp circuit breaker open.
- Open ECM fuse.
- Battery circuit to ECM open.
- Ignition circuit to ECM open.
- Poor connection to ECM.
- Faulty ECM ground circuit(s).

Engine will not crank.

- Perform EFI system relay check.

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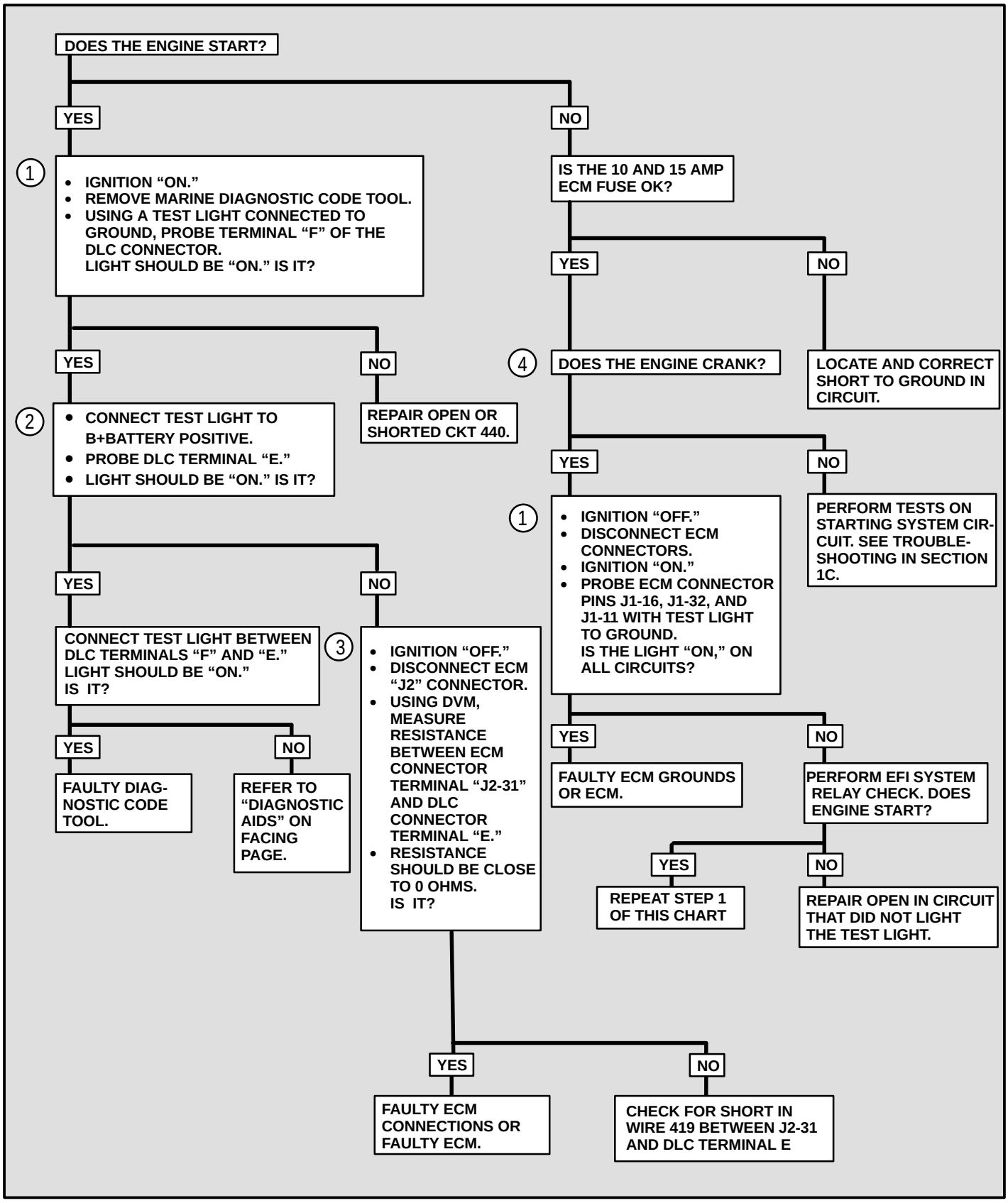
No “Malfunction Indicator Lamp”
Chart A-1: (2 of 2)


DOES THE ENGINE START?
YES
NO
1
IGNITION “ON.”
REMOVE MARINE DIAGNOSTIC CODE TOOL.
USING A TEST LIGHT CONNECTED TO GROUND, PROBE TERMINAL “F” OF THE DLC CONNECTOR.
LIGHT SHOULD BE “ON.” IS IT?
YES
NO
REPAIR OPEN OR SHORTED CKT 440.
2
CONNECT TEST LIGHT TO B+BATTERY POSITIVE.
PROBE DLC TERMINAL “E.”
LIGHT SHOULD BE “ON.” IS IT?
YES
NO
CONNECT TEST LIGHT BETWEEN DLC TERMINALS “F” AND “E.” LIGHT SHOULD BE “ON.” IS IT?
3
IGNITION “OFF.”
DISCONNECT ECM “J2” CONNECTOR.
USING DVM, MEASURE RESISTANCE BETWEEN ECM CONNECTOR TERMINAL “J2-31” AND DLC CONNECTOR TERMINAL “E.”
RESISTANCE SHOULD BE CLOSE TO 0 OHMS. IS IT?
YES
NO
FAULTY DIAG-NOSTIC CODE TOOL.
REFER TO “DIAGNOSTIC AIDS” ON FACING PAGE.
YES
NO
FAULTY ECM CONNECTIONS OR FAULTY ECM.
CHECK FOR SHORT IN WIRE 419 BETWEEN J2-31 AND DLC TERMINAL E
IS THE 10 AND 15 AMP ECM FUSE OK?
YES
NO
4
DOES THE ENGINE CRANK?
LOCATE AND CORRECT SHORT TO GROUND IN CIRCUIT.
YES
NO
1
IGNITION “OFF.”
DISCONNECT ECM CONNECTORS.
IGNITION “ON.”
PROBE ECM CONNECTOR PINS J1-16, J1-32, AND J1-11 WITH TEST LIGHT TO GROUND. IS THE LIGHT “ON,” ON ALL CIRCUITS?
PERFORM TESTS ON STARTING SYSTEM CIR-CUIT. SEE TROUBLE-SHOOTING IN SECTION 1C.
YES
NO
FAULTY ECM GROUNDS OR ECM.
PERFORM EFI SYSTEM RELAY CHECK. DOES ENGINE START?
YES
NO
REPEAT STEP 1 OF THIS CHART
REPAIR OPEN IN CIRCUIT THAT DID NOT LIGHT THE TEST LIGHT.

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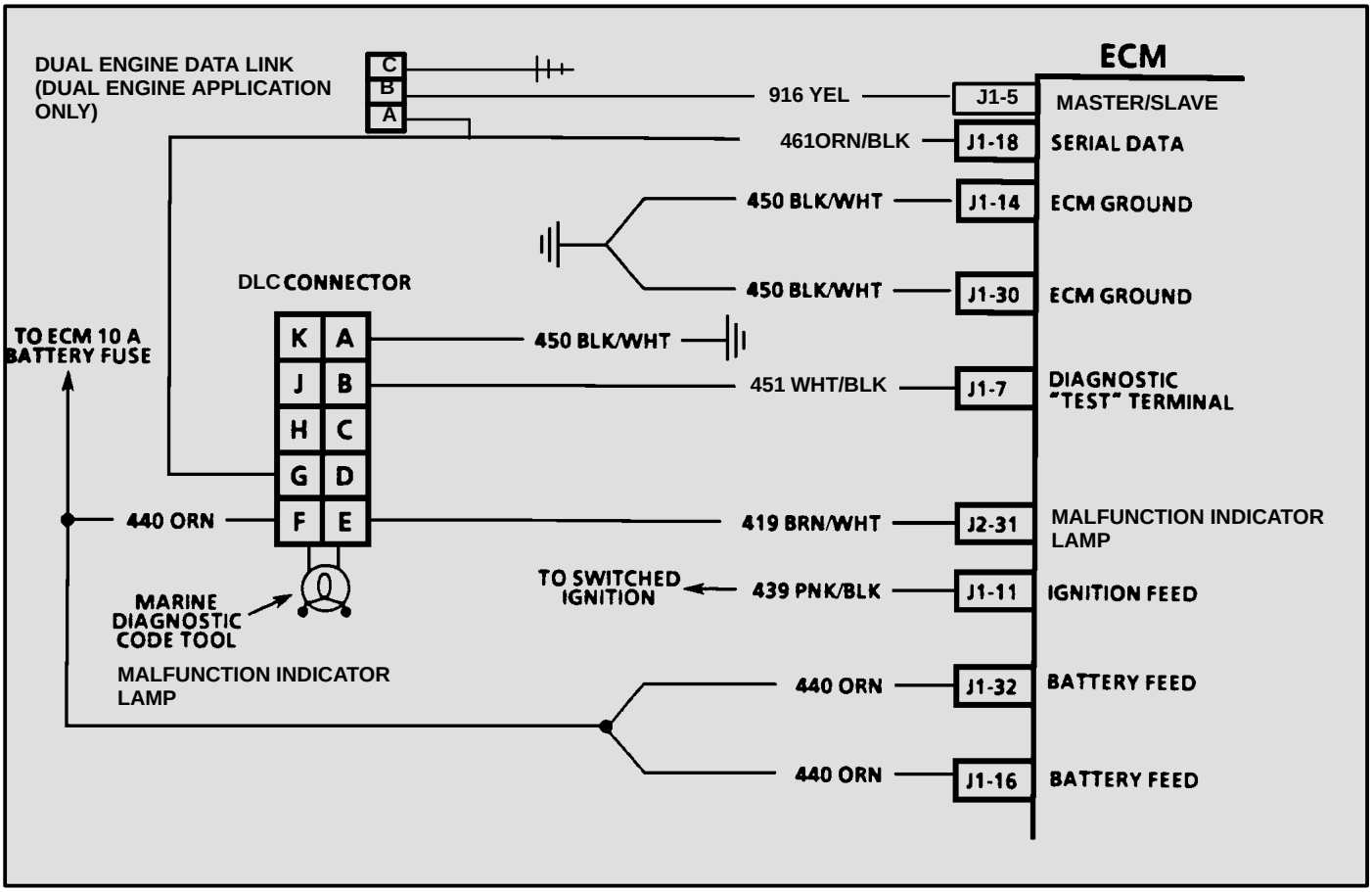
No DLC Data or Will Not Flash Code 12 “Malfunction Indicator Lamp” On Steady (Marine Diagnostic Code Tool Installed)
Chart A-2 (1 of 2)



CIRCUIT DESCRIPTION:

There should always be a steady “Malfunction Indicator Lamp” when the ignition is ON and engine stopped. Ignition voltage is supplied to the light bulb. The Engine Control Module (ECM) will turn the lamp ON by grounding CKT 419 in the ECM.

With the diagnostic “test” terminal grounded CKT 419, the lamp should flash a Code 12, followed by any trouble code(s) stored in memory.

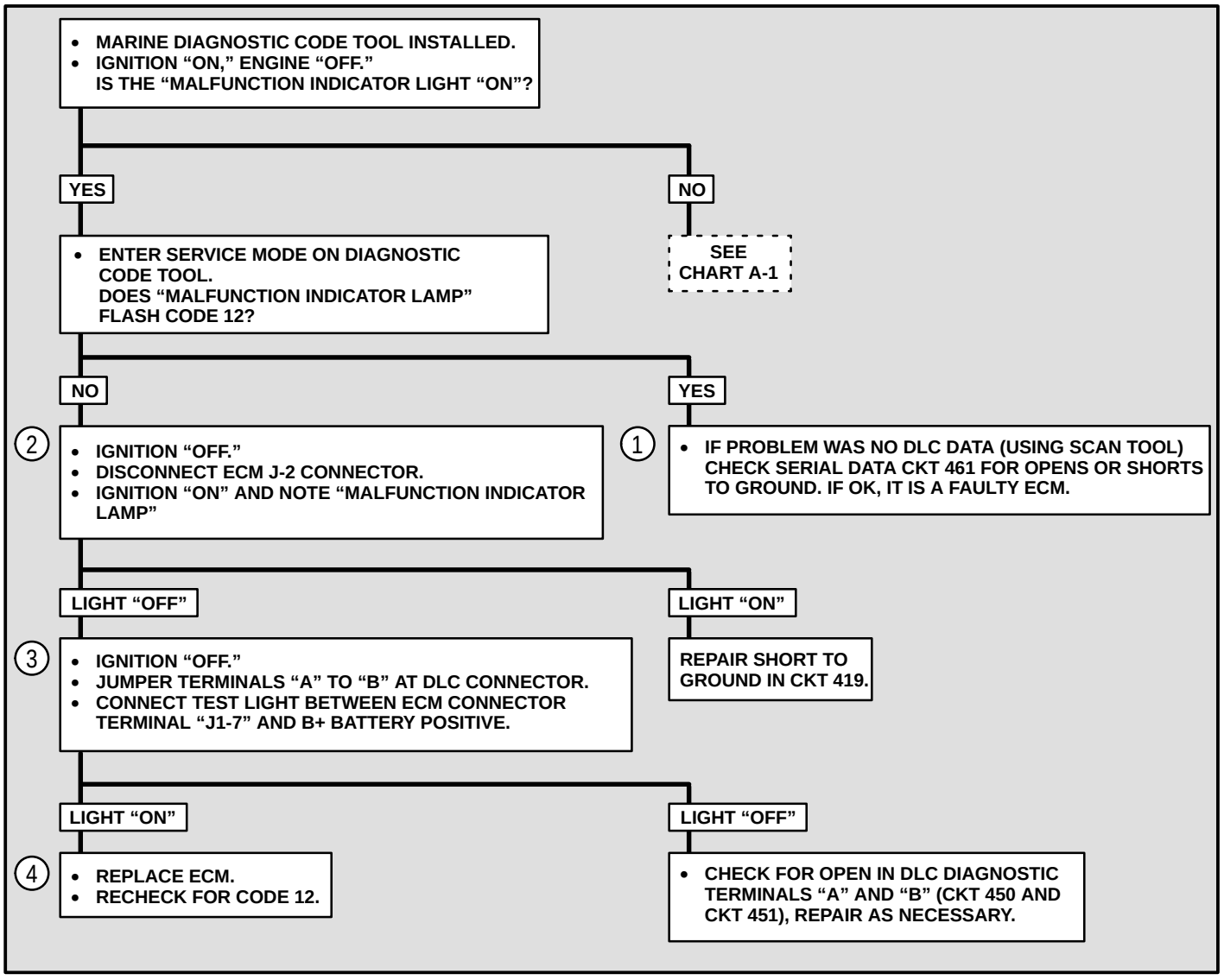
A steady light suggests a short to ground in the lamp control CKT 419 or an open in diagnostic CKT 451.

TEST DESCRIPTION:

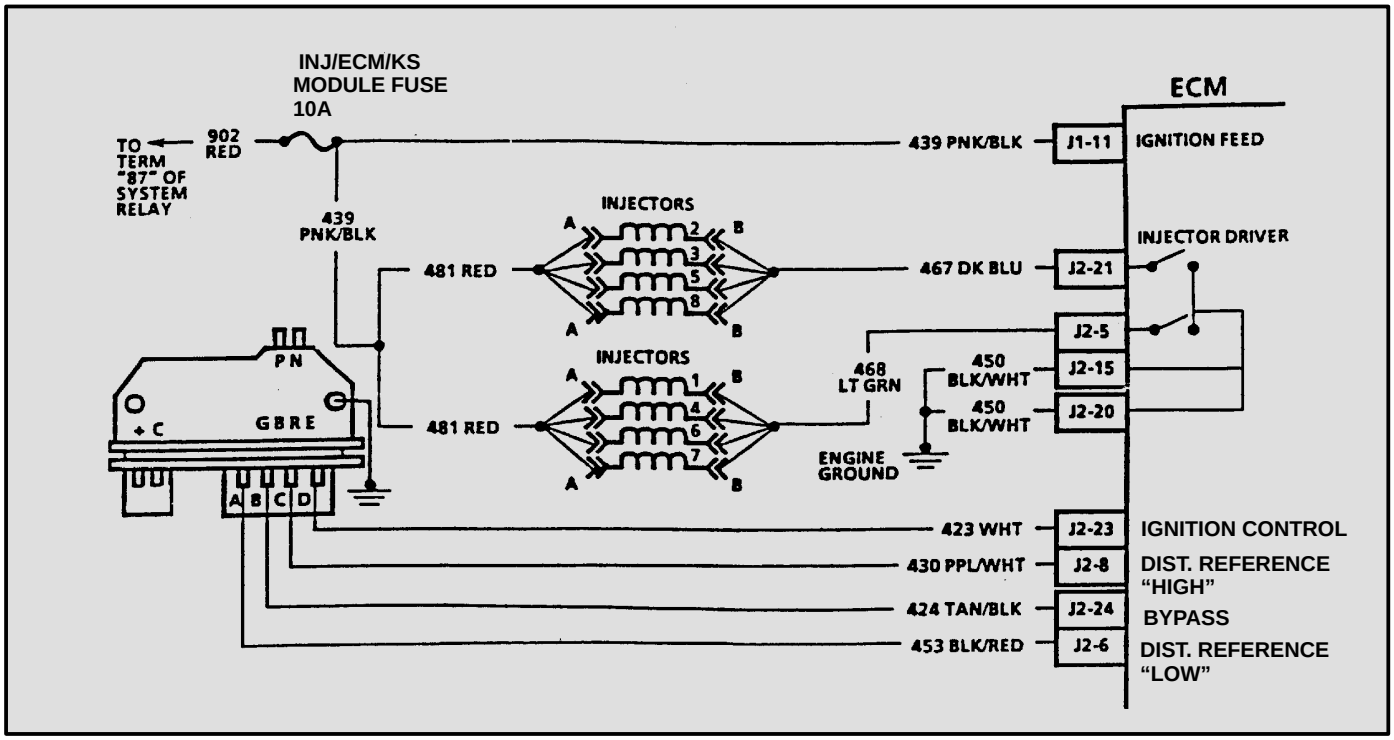
Number(s) below refer to circled number(s) on the diagnostic chart.

1. If there is a problem with the ECM that causes a scan tool to not read serial data, the ECM should not flash a Code 12. If Code 12 is flashing, check CKT 451 for short to ground. If Code 12 does flash, make sure that the scan tool is working properly on another engine.
2. If the light goes OFF when the ECM connector is disconnected, CKT 419 is not shorted to ground.
3. This step will check for an open diagnostic CKT 451.
4. At this point, the “Malfunction Indicator Lamp” wiring is OK. If Code 12 does not flash, the ECM should be replaced.

No DLC Data or Will Not Flash Code 12
Chart A-2: (2 of 2)


• MARINE DIAGNOSTIC CODE TOOL INSTALLED.
• IGNITION "ON," ENGINE "OFF."
IS THE "MALFUNCTION INDICATOR LIGHT "ON"?
YES
NO
• ENTER SERVICE MODE ON DIAGNOSTIC CODE TOOL.
DOES "MALFUNCTION INDICATOR LAMP" FLASH CODE 12?
SEE CHART A-1
NO
YES
2
• IGNITION "OFF."
• DISCONNECT ECM J-2 CONNECTOR.
• IGNITION "ON" AND NOTE "MALFUNCTION INDICATOR LAMP"
1
• IF PROBLEM WAS NO DLC DATA (USING SCAN TOOL) CHECK SERIAL DATA CKT 461 FOR OPENS OR SHORTS TO GROUND. IF OK, IT IS A FAULTY ECM.
LIGHT "OFF"
LIGHT "ON"
3
• IGNITION "OFF."
• JUMPER TERMINALS "A" TO "B" AT DLC CONNECTOR.
• CONNECT TEST LIGHT BETWEEN ECM CONNECTOR TERMINAL "J1-7" AND B+ BATTERY POSITIVE.
REPAIR SHORT TO GROUND IN CKT 419.
LIGHT "ON"
LIGHT "OFF"
4
• REPLACE ECM.
• RECHECK FOR CODE 12.
• CHECK FOR OPEN IN DLC DIAGNOSTIC TERMINALS "A" AND "B" (CKT 450 AND CKT 451), REPAIR AS NECESSARY.

Engine Cranks but Will Not Run Chart A-3 (1 of 4)



CIRCUIT DESCRIPTION:

This chart assumes that battery condition and engine cranking speed are OK, and there is adequate fuel in the tank.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. An ECT sensor that indicates coolant temperature less than actual temperature can flood the engine with fuel. An ECT sensor that indicates coolant temperature greater than actual can starve the engine of fuel. If the TP sensor is at 50 to 75% of its range, the engine may be in the clear flood mode, which will cause starting problems. The engine will not start without reference pulses and, therefore, the scan tool should read engine RPM (reference) during cranking.
2. No spark may be caused by one of several components related to the high energy ignition/IC system. The ignition system will address all problems related to the causes of a no spark condition.
3. The test light should blink, indicating the ECM is controlling the injectors OK.
4. All injectors should be within 1.0 ohm of each other and should not be less than 12 ohms at 70°F (21°C). If an injector is suspected for a no start condition, unhook the suspected injector and try to start the engine.
5. Use fuel pressure gauge 91-16850 or J-34730-1. Wrap a shop towel around the fuel pressure tap to absorb any small amount of fuel leakage that may occur when installing the gauge.

DIAGNOSTIC AIDS:

- Unless engine enters “Clear Flood” at the first indication of a flooding condition, it can result in a no start.
- Check for fouled plugs.
- Water or foreign material in fuel line, VST, water separating fuel filter can cause a no start in cold weather.
- A defective MAP sensor may cause a no start or a stall after start. To determine if the sensor is causing the problem, disconnect it. The ECM will then use a default value for the sensor, and if the condition is corrected and the connections are OK, replace the sensor.
- Using injector harness test light (J-34730-2A) check for blinking light at injector harness on both banks of the engine. If not OK, check injector fuses.

If above are all OK, refer to “Troubleshooting.”

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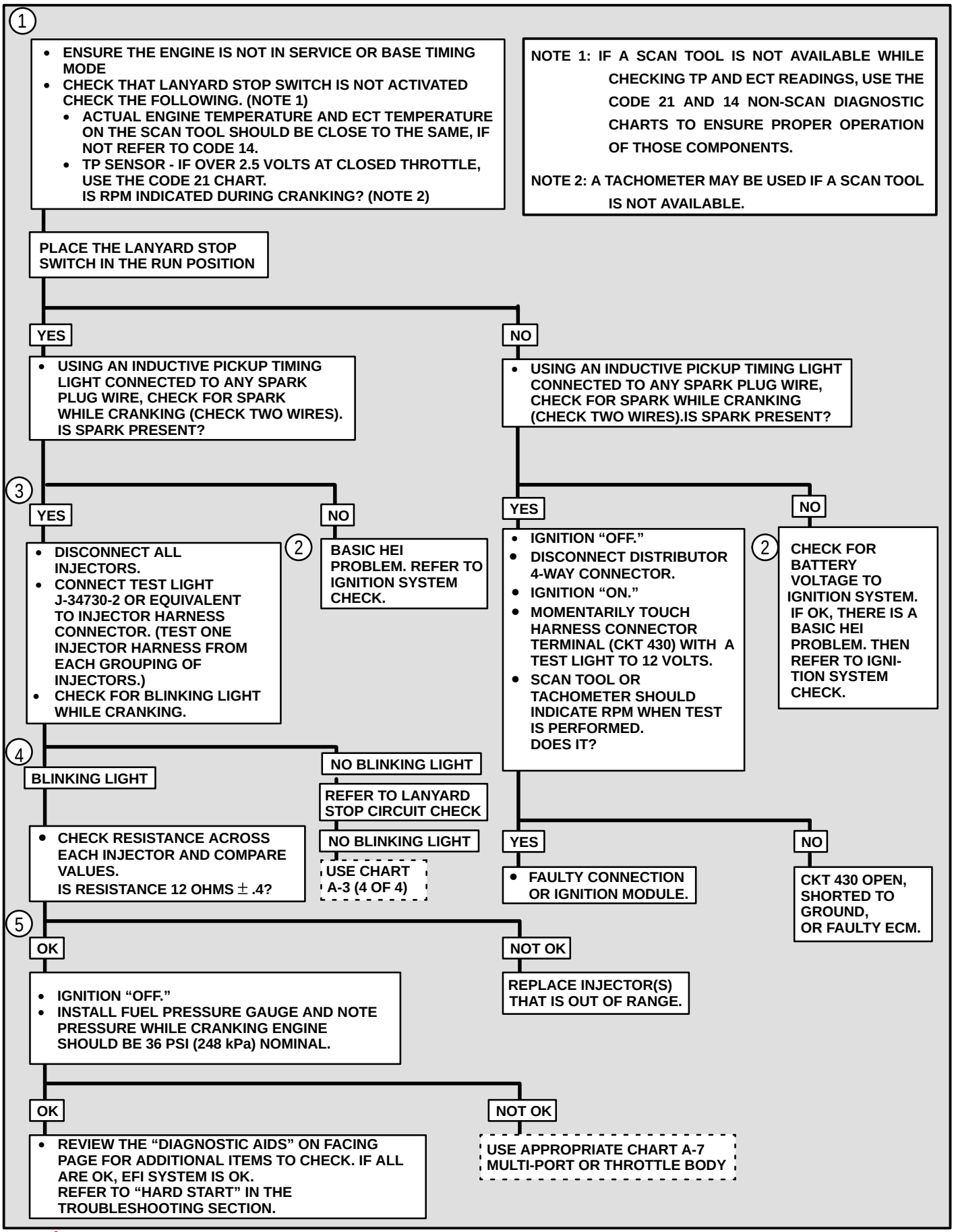
Engine Cranks but Will Not Run (Continued)
Chart A-3: (2 of 4)


1
ENSURE THE ENGINE IS NOT IN SERVICE OR BASE TIMING MODE
CHECK THAT LANYARD STOP SWITCH IS NOT ACTIVATED
CHECK THE FOLLOWING. (NOTE 1)
ACTUAL ENGINE TEMPERATURE AND ECT TEMPERATURE ON THE SCAN TOOL SHOULD BE CLOSE TO THE SAME, IF NOT REFER TO CODE 14.
TP SENSOR - IF OVER 2.5 VOLTS AT CLOSED THROTTLE, USE THE CODE 21 CHART.
IS RPM INDICATED DURING CRANKING? (NOTE 2)
NOTE 1: IF A SCAN TOOL IS NOT AVAILABLE WHILE CHECKING TP AND ECT READINGS, USE THE CODE 21 AND 14 NON-SCAN DIAGNOSTIC CHARTS TO ENSURE PROPER OPERATION OF THOSE COMPONENTS.
NOTE 2: A TACHOMETER MAY BE USED IF A SCAN TOOL IS NOT AVAILABLE.
PLACE THE LANYARD STOP SWITCH IN THE RUN POSITION
YES
NO
USING AN INDUCTIVE PICKUP TIMING LIGHT CONNECTED TO ANY SPARK PLUG WIRE, CHECK FOR SPARK WHILE CRANKING (CHECK TWO WIRES). IS SPARK PRESENT?
USING AN INDUCTIVE PICKUP TIMING LIGHT CONNECTED TO ANY SPARK PLUG WIRE, CHECK FOR SPARK WHILE CRANKING (CHECK TWO WIRES).IS SPARK PRESENT?
3
YES
NO
2
BASIC HEI PROBLEM. REFER TO IGNITION SYSTEM CHECK.
DISCONNECT ALL INJECTORS.
CONNECT TEST LIGHT J-34730-2 OR EQUIVALENT TO INJECTOR HARNESS CONNECTOR. (TEST ONE INJECTOR HARNESS FROM EACH GROUPING OF INJECTORS.)
CHECK FOR BLINKING LIGHT WHILE CRANKING.
YES
NO
2
IGNITION "OFF."
DISCONNECT DISTRIBUTOR 4-WAY CONNECTOR.
IGNITION "ON."
MOMENTARILY TOUCH HARNESS CONNECTOR TERMINAL (CKT 430) WITH A TEST LIGHT TO 12 VOLTS.
SCAN TOOL OR TACHOMETER SHOULD INDICATE RPM WHEN TEST IS PERFORMED.
DOES IT?
CHECK FOR BATTERY VOLTAGE TO IGNITION SYSTEM. IF OK, THERE IS A BASIC HEI PROBLEM. THEN REFER TO IGNITION SYSTEM CHECK.
4
BLINKING LIGHT
NO BLINKING LIGHT
REFER TO LANYARD STOP CIRCUIT CHECK
NO BLINKING LIGHT
USE CHART A-3 (4 OF 4)
CHECK RESISTANCE ACROSS EACH INJECTOR AND COMPARE VALUES.
IS RESISTANCE 12 OHMS ± .4?
YES
NO
FAULTY CONNECTION OR IGNITION MODULE.
CKT 430 OPEN, SHORTED TO GROUND, OR FAULTY ECM.
5
OK
NOT OK
IGNITION "OFF."
INSTALL FUEL PRESSURE GAUGE AND NOTE PRESSURE WHILE CRANKING ENGINE SHOULD BE 36 PSI (248 kPa) NOMINAL.
REPLACE INJECTOR(S) THAT IS OUT OF RANGE.
OK
NOT OK
REVIEW THE "DIAGNOSTIC AIDS" ON FACING PAGE FOR ADDITIONAL ITEMS TO CHECK. IF ALL ARE OK, EFI SYSTEM IS OK.
REFER TO "HARD START" IN THE TROUBLESHOOTING SECTION.
USE APPROPRIATE CHART A-7 MULTI-PORT OR THROTTLE BODY

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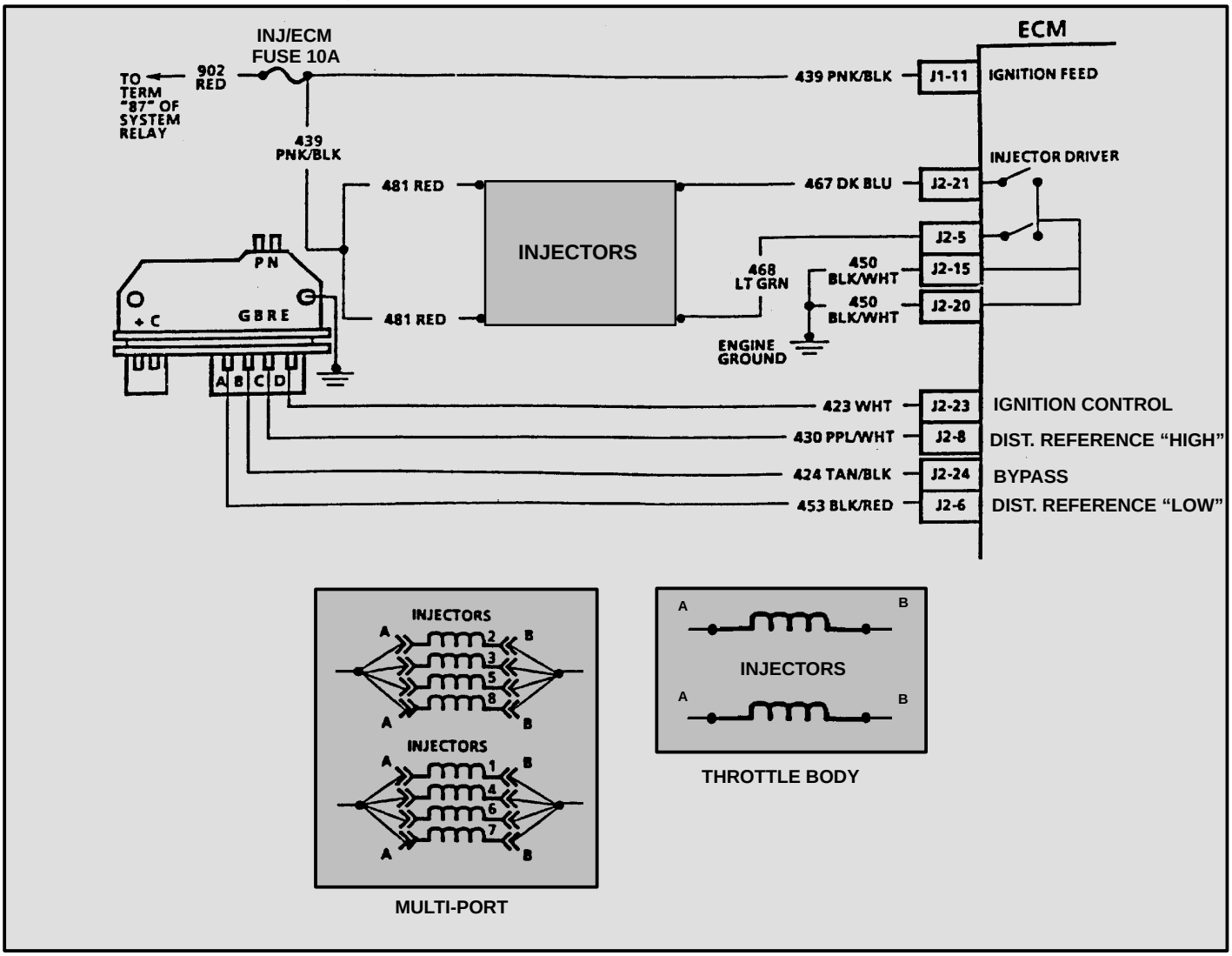
Engine Cranks but Will Not Run (Continued)
Chart A-3 (3 of 4)



TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Check for 12 volt supply to injectors. Due to the injectors wired in parallel, there should be a light ON on both terminals.
2. Check continuity of CKT 467 and CKT 468.
3. All checks made to this point would indicate that the ECM is at fault. However, there is a possibility of CKT 467 or CKT 468 being shorted to a voltage source either in the engine harness or in the injector harness.

To test for this condition:

- Disconnect all injectors.
- Ignition ON.
- Probe CKT 467 and CKT 468 on the ECM side of injector harness with a test light connected to ground. (Test one injector harness on each side of engine.) There should be no light. If light is ON, repair short to voltage.
- If OK, check the resistance of the injectors. Should be 12 ohms $\pm$ 4.
- Check injector harness connector. Be sure terminals are not backed out of connector and contacting each other.
- If all OK, replace ECM.

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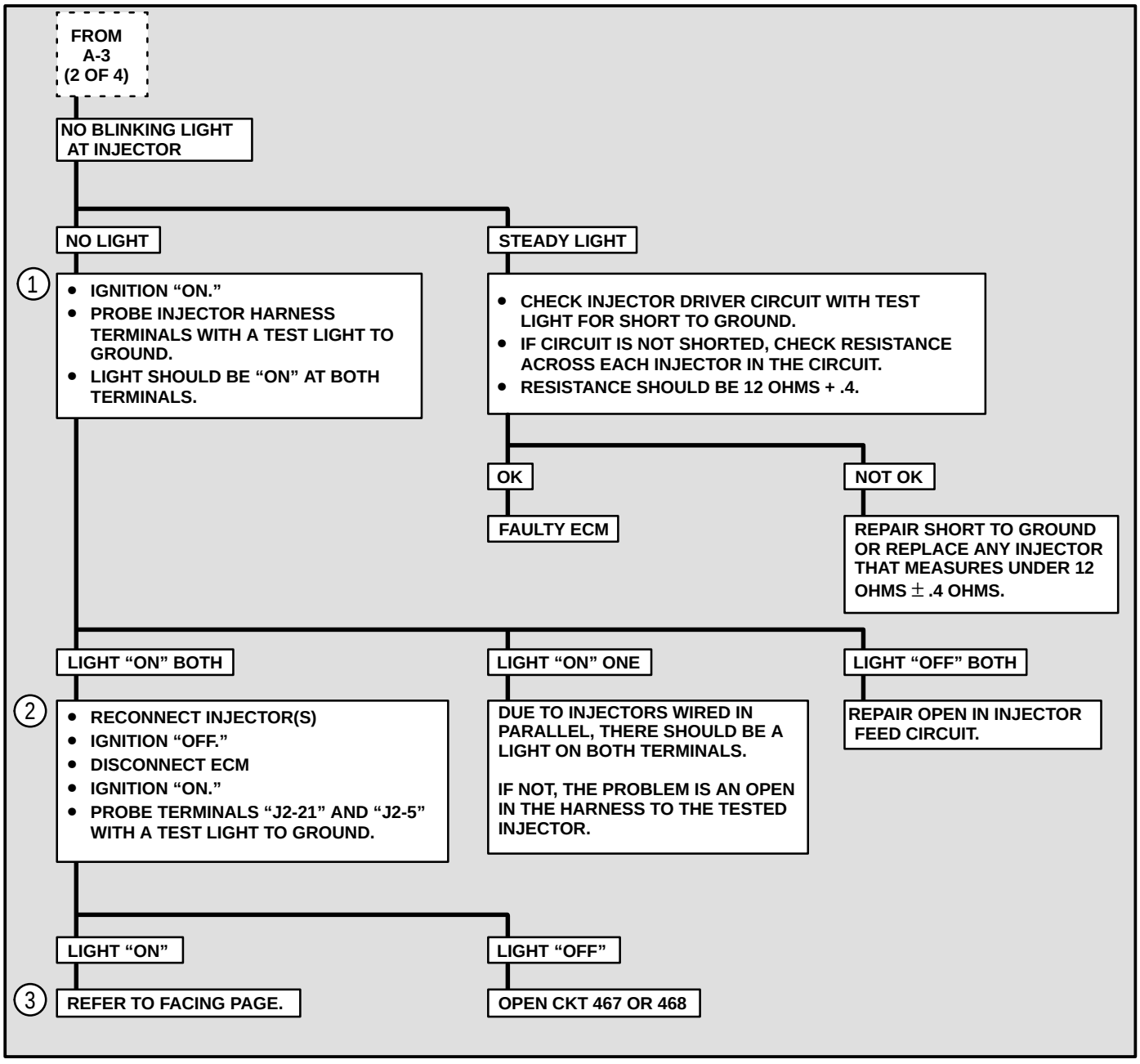
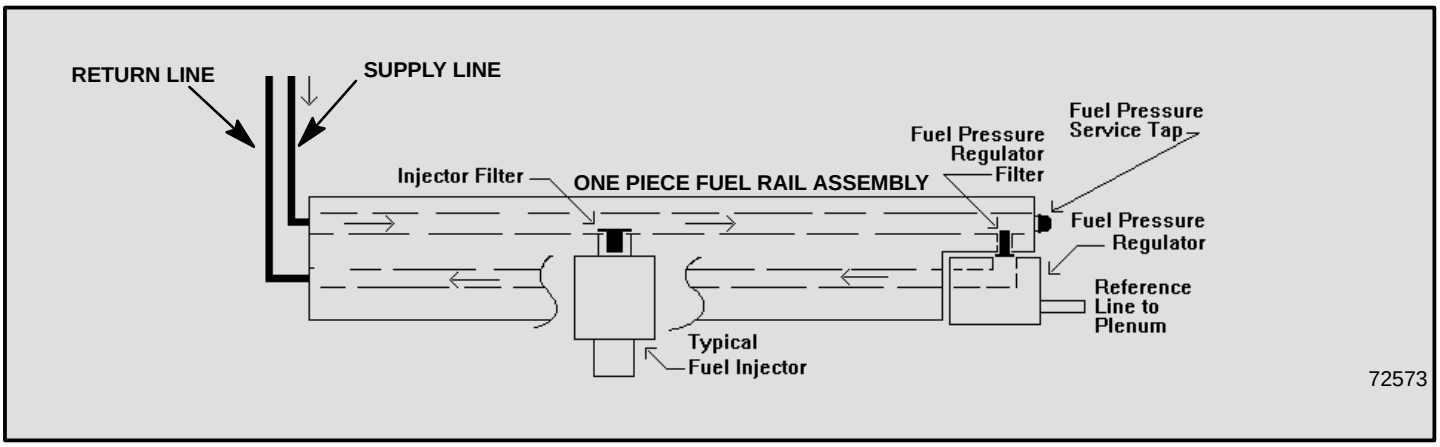
Engine Cranks but Will Not Run (Continued)
Chart A-3: (4 of 4)


FROM A-3 (2 OF 4)
NO BLINKING LIGHT AT INJECTOR
NO LIGHT
STEADY LIGHT
1
IGNITION "ON."
PROBE INJECTOR HARNESS TERMINALS WITH A TEST LIGHT TO GROUND.
LIGHT SHOULD BE "ON" AT BOTH TERMINALS.
CHECK INJECTOR DRIVER CIRCUIT WITH TEST LIGHT FOR SHORT TO GROUND.
IF CIRCUIT IS NOT SHORTED, CHECK RESISTANCE ACROSS EACH INJECTOR IN THE CIRCUIT.
RESISTANCE SHOULD BE 12 OHMS + .4.
OK
NOT OK
FAULTY ECM
REPAIR SHORT TO GROUND OR REPLACE ANY INJECTOR THAT MEASURES UNDER 12 OHMS ± .4 OHMS.
LIGHT "ON" BOTH
LIGHT "ON" ONE
LIGHT "OFF" BOTH
2
RECONNECT INJECTOR(S)
IGNITION "OFF."
DISCONNECT ECM
IGNITION "ON."
PROBE TERMINALS "J2-21" AND "J2-5" WITH A TEST LIGHT TO GROUND.
DUE TO INJECTORS WIRED IN PARALLEL, THERE SHOULD BE A LIGHT ON BOTH TERMINALS.
IF NOT, THE PROBLEM IS AN OPEN IN THE HARNESS TO THE TESTED INJECTOR.
REPAIR OPEN IN INJECTOR FEED CIRCUIT.
LIGHT "ON"
LIGHT "OFF"
3
REFER TO FACING PAGE.
OPEN CKT 467 OR 468

Multi-Port Injection Fuel System Diagnosis
Chart A-7 (1 of 6)



CIRCUIT DESCRIPTION:

During engine cranking, the Engine Control Module (ECM) will turn ON the electric fuel pump in the vapor separator tank. It will remain ON as long as the engine is cranking or running, and the ECM is receiving reference pulses. If there are no reference pulses, the ECM will shut OFF the fuel pump.

The pump will deliver fuel to the fuel rail and injectors, then to the pressure regulator, where the system pressure is controlled to about 36 PSI (248 kPa) nominal. Excess fuel is then returned to the vapor separator tank.

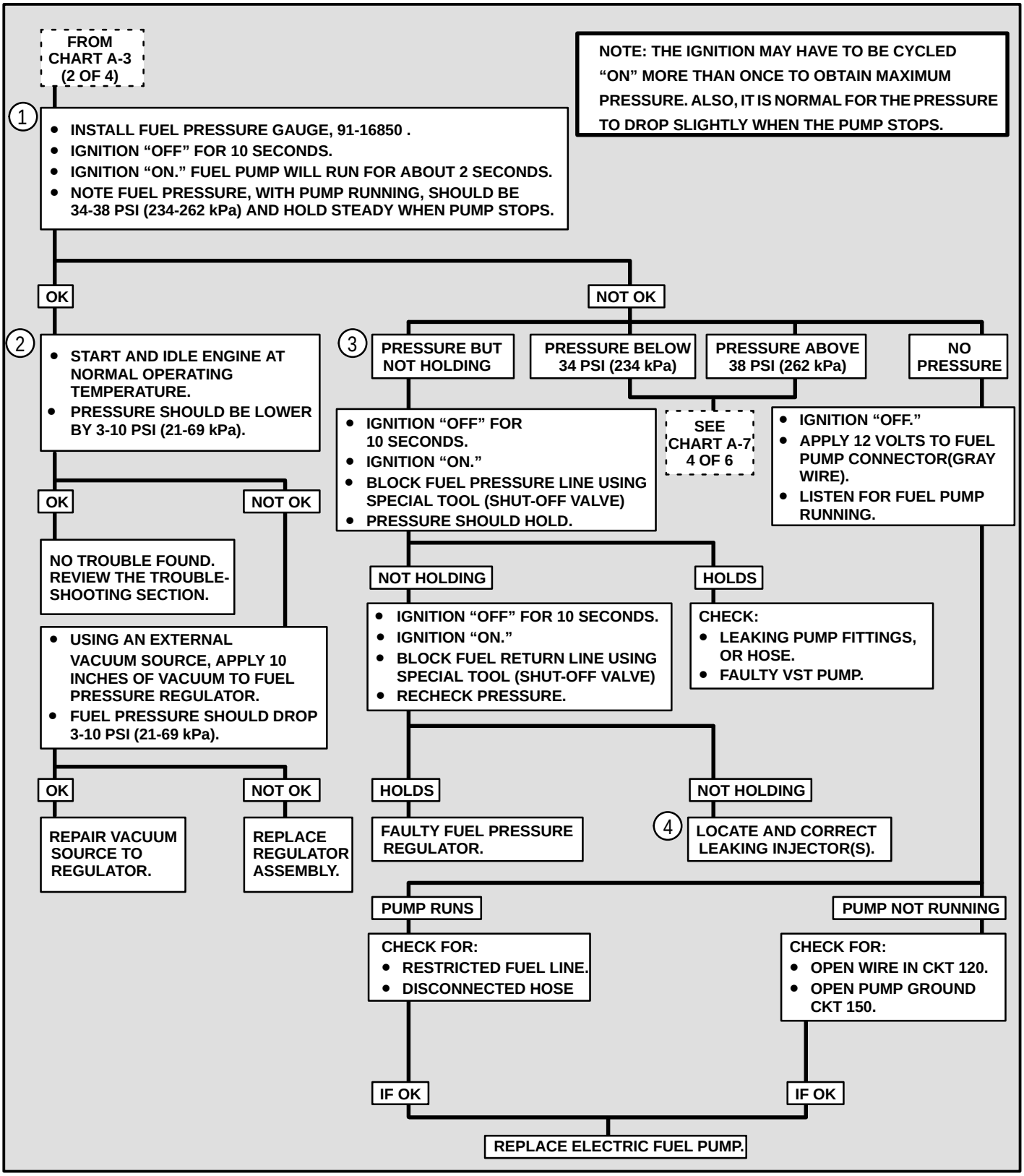
TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. If pump does not run check fuel pump relay and fuse.
2. Wrap a shop towel around the fuel pressure connector to absorb any small amount of fuel leakage that may occur when installing the gauge.

   Ignition ON, pump pressure should be 34-38 PSI (234-262 kPa). This pressure is controlled by spring pressure within the regulator assembly.
3. When the engine is idling, high vacuum is applied to the fuel regulator diaphragm. This will offset the spring and result in a lower fuel pressure. This idle vacuum will vary somewhat depending on barometric pressure; however, the fuel pressure at idle should be less, indicating fuel pressure regulator control.
4. Pressure that leaks down is caused by one of the following:
   - Fuel pressure regulator valve leaking.
   - Injector(s) sticking open.
   - Check vent line from VST to see if diaphragm is leaking.
5. If an injector is stuck open, it will send fuel to its respective cylinder, which may saturate or foul spark plug(s). In order to determine which injector is leaking, the spark plugs must be removed and inspected for fouling or saturation. Once the saturated spark plug(s) is found, replace the corresponding injector(s) and install new spark plug(s).

Multi-Port Injection Fuel System Diagnosis (Continued)
Chart A-7: (2 of 6)


FROM CHART A-3 (2 OF 4)
NOTE: THE IGNITION MAY HAVE TO BE CYCLED "ON" MORE THAN ONCE TO OBTAIN MAXIMUM PRESSURE. ALSO, IT IS NORMAL FOR THE PRESSURE TO DROP SLIGHTLY WHEN THE PUMP STOPS.
1
INSTALL FUEL PRESSURE GAUGE, 91-16850 .
IGNITION "OFF" FOR 10 SECONDS.
IGNITION "ON." FUEL PUMP WILL RUN FOR ABOUT 2 SECONDS.
NOTE FUEL PRESSURE, WITH PUMP RUNNING, SHOULD BE 34-38 PSI (234-262 kPa) AND HOLD STEADY WHEN PUMP STOPS.
OK
NOT OK
2
START AND IDLE ENGINE AT NORMAL OPERATING TEMPERATURE.
PRESSURE SHOULD BE LOWER BY 3-10 PSI (21-69 kPa).
OK
NOT OK
NO TROUBLE FOUND. REVIEW THE TROUBLE-SHOOTING SECTION.
USING AN EXTERNAL VACUUM SOURCE, APPLY 10 INCHES OF VACUUM TO FUEL PRESSURE REGULATOR.
FUEL PRESSURE SHOULD DROP 3-10 PSI (21-69 kPa).
OK
NOT OK
REPAIR VACUUM SOURCE TO REGULATOR.
REPLACE REGULATOR ASSEMBLY.
3
PRESSURE BUT NOT HOLDING
PRESSURE BELOW 34 PSI (234 kPa)
PRESSURE ABOVE 38 PSI (262 kPa)
NO PRESSURE
IGNITION "OFF" FOR 10 SECONDS.
IGNITION "ON."
BLOCK FUEL PRESSURE LINE USING SPECIAL TOOL (SHUT-OFF VALVE)
PRESSURE SHOULD HOLD.
SEE CHART A-7 4 OF 6
IGNITION "OFF."
APPLY 12 VOLTS TO FUEL PUMP CONNECTOR(GRAY WIRE).
LISTEN FOR FUEL PUMP RUNNING.
NOT HOLDING
HOLDS
IGNITION "OFF" FOR 10 SECONDS.
IGNITION "ON."
BLOCK FUEL RETURN LINE USING SPECIAL TOOL (SHUT-OFF VALVE)
RECHECK PRESSURE.
CHECK:
LEAKING PUMP FITTINGS, OR HOSE.
FAULTY VST PUMP.
HOLDS
NOT HOLDING
FAULTY FUEL PRESSURE REGULATOR.
4
LOCATE AND CORRECT LEAKING INJECTOR(S).
PUMP RUNS
PUMP NOT RUNNING
CHECK FOR:
RESTRICTED FUEL LINE.
DISCONNECTED HOSE
CHECK FOR:
OPEN WIRE IN CKT 120.
OPEN PUMP GROUND CKT 150.
IF OK
IF OK
REPLACE ELECTRIC FUEL PUMP.

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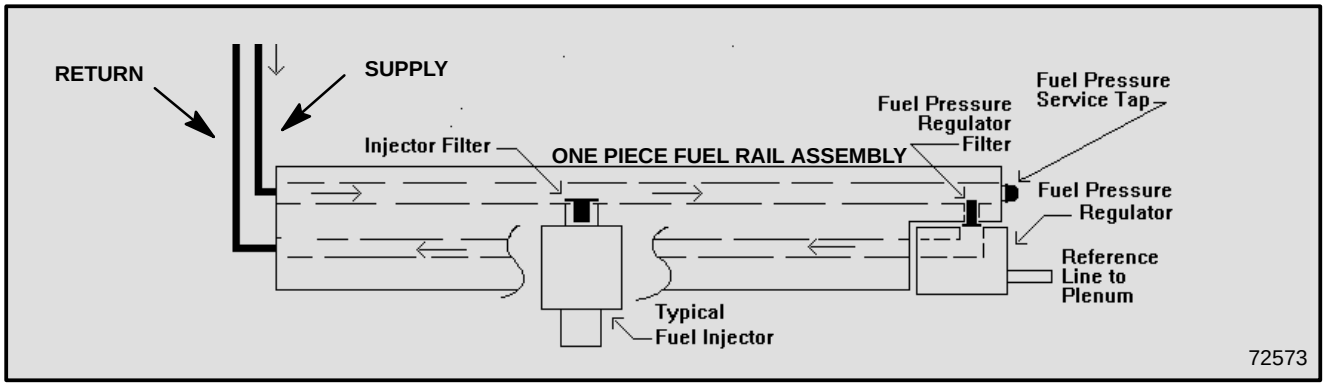
Multi-Port Injection Fuel System Diagnosis (Continued)
Chart A-7 (3 of 6)



Check for contaminated fuel tank, struck anti siphon valve or vacuum leak anywhere before the mechanical fuel pump. Also possible slipping seawater/fuel pump drive belt.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Pressure less than 34 PSI (234 kPa) falls into two areas:

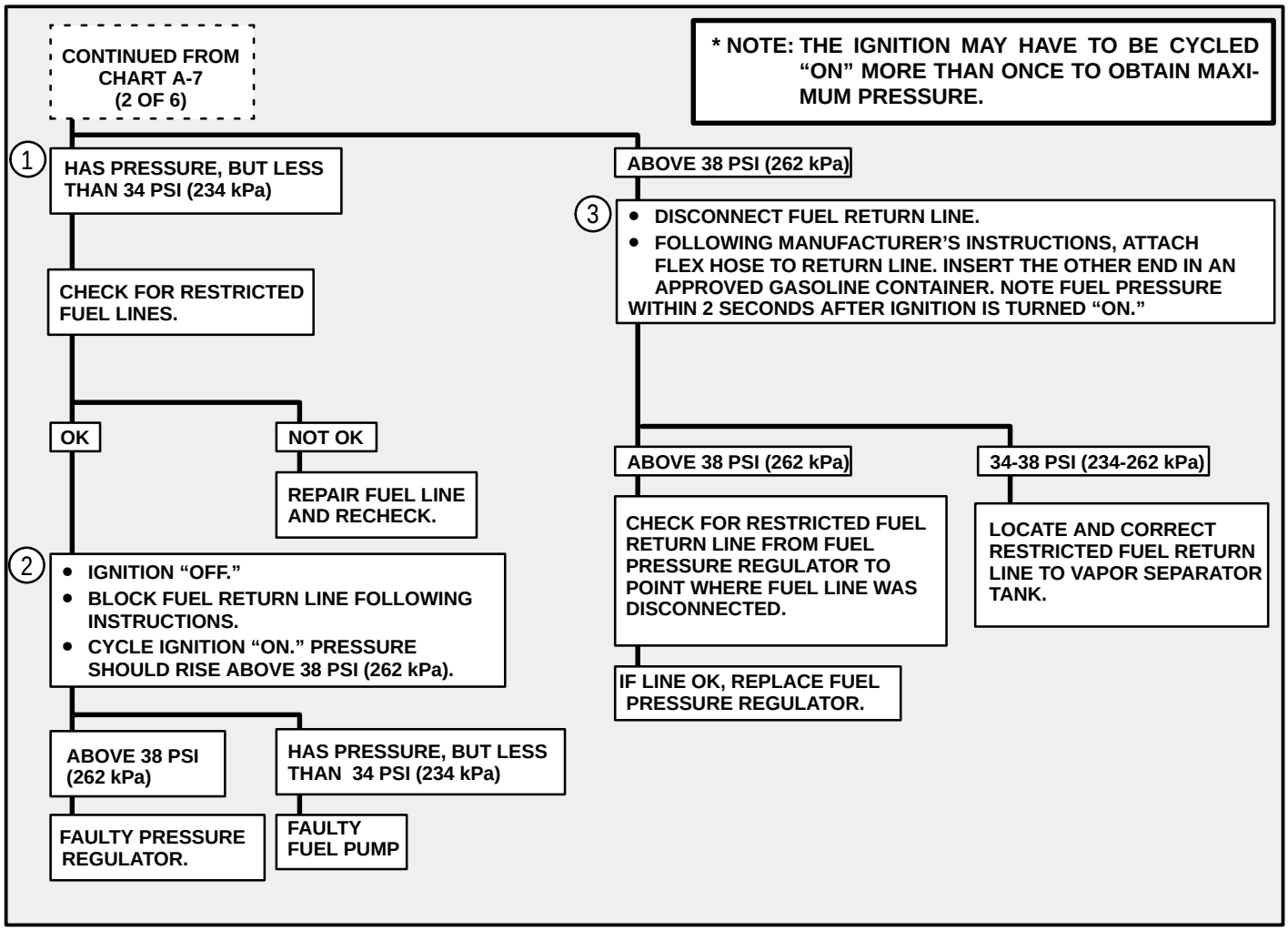
- Regulated pressure less than 34 PSI (234 kPa). The system will be running lean. Also, hard starting when cold and overall poor performance will be noticed.
- Restricted flow causing pressure drop. Normally, an engine with a fuel pressure of less than 24 PSI (165 kPa) at idle will not be driveable. However, if the pressure drop occurs only while underway, the engine will surge then stop running as pressure begins to drop rapidly. This is most likely caused by a restricted fuel line or plugged water separating fuel filter.

2. Restricting the fuel return line (Using Special Tool - Shut-Off Valve) allows the fuel pressure to build above regulated pressure. With battery voltage applied to the fuel pump, pressure should rise to 60 PSI (414 kPa) as the fuel return hose is gradually pinched.

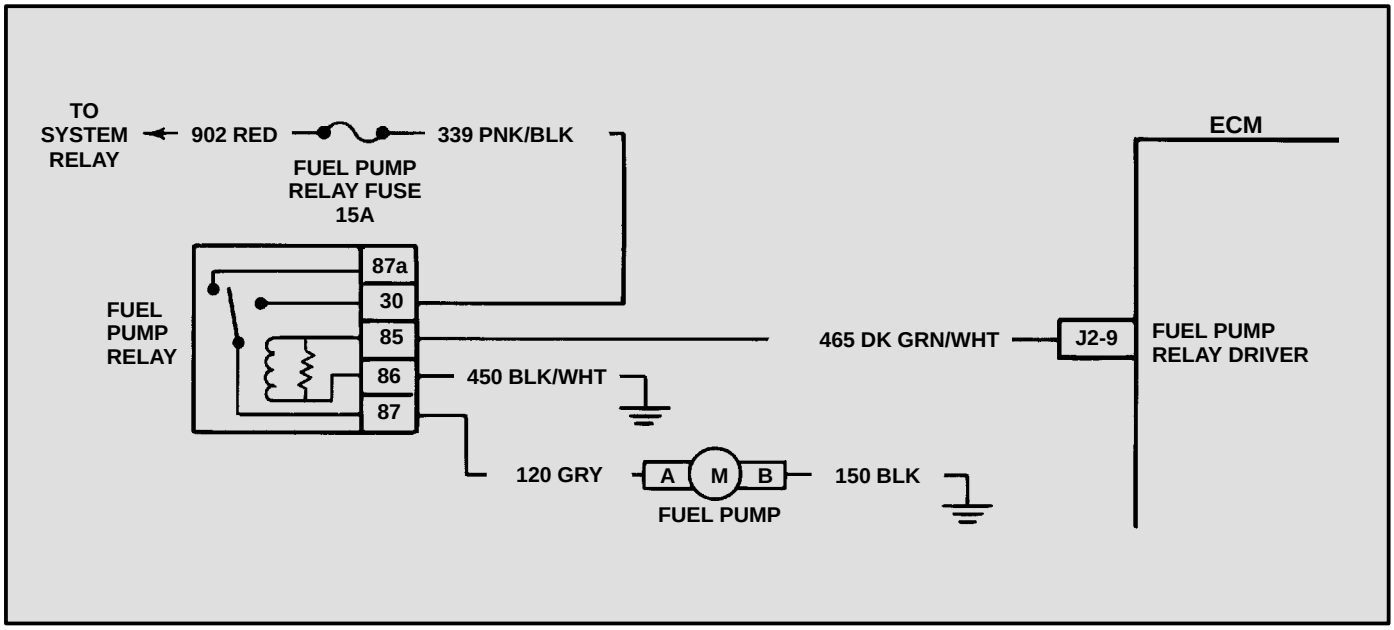
NOTE: *Do not allow fuel pressure to exceed 60 PSI (414 kPa); damage to the pressure regulator may result.*

3. This test determines if the high fuel pressure is due to a restricted fuel return line or a pressure regulator problem.

Multi-Port Injection Fuel System Diagnosis (Continued)
Chart A-7: (4 of 6)


CONTINUED FROM CHART A-7 (2 OF 6)
* NOTE: THE IGNITION MAY HAVE TO BE CYCLED "ON" MORE THAN ONCE TO OBTAIN MAXIMUM PRESSURE.
1
HAS PRESSURE, BUT LESS THAN 34 PSI (234 kPa)
CHECK FOR RESTRICTED FUEL LINES.
OK
NOT OK
REPAIR FUEL LINE AND RECHECK.
2
IGNITION "OFF."
BLOCK FUEL RETURN LINE FOLLOWING INSTRUCTIONS.
CYCLE IGNITION "ON." PRESSURE SHOULD RISE ABOVE 38 PSI (262 kPa).
ABOVE 38 PSI (262 kPa)
FAULTY PRESSURE REGULATOR.
HAS PRESSURE, BUT LESS THAN 34 PSI (234 kPa)
FAULTY FUEL PUMP
ABOVE 38 PSI (262 kPa)
3
DISCONNECT FUEL RETURN LINE.
FOLLOWING MANUFACTURER'S INSTRUCTIONS, ATTACH FLEX HOSE TO RETURN LINE. INSERT THE OTHER END IN AN APPROVED GASOLINE CONTAINER. NOTE FUEL PRESSURE WITHIN 2 SECONDS AFTER IGNITION IS TURNED "ON."
ABOVE 38 PSI (262 kPa)
CHECK FOR RESTRICTED FUEL RETURN LINE FROM FUEL PRESSURE REGULATOR TO POINT WHERE FUEL LINE WAS DISCONNECTED.
IF LINE OK, REPLACE FUEL PRESSURE REGULATOR.
34-38 PSI (234-262 kPa)
LOCATE AND CORRECT RESTRICTED FUEL RETURN LINE TO VAPOR SEPARATOR TANK.

Multi-Port Injection Fuel System Diagnosis (Continued)
Chart A-7 (5 of 6)



TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step checks if there is power to the fuel pump relay.
2. Bypassing the relay circuit should cause the fuel pump to run. This step should identify if the fault is in the relay or in the fuel pump circuit.
3. This step checks if there is an open in the ground circuit.
4. This step checks if the ECM is functioning properly.

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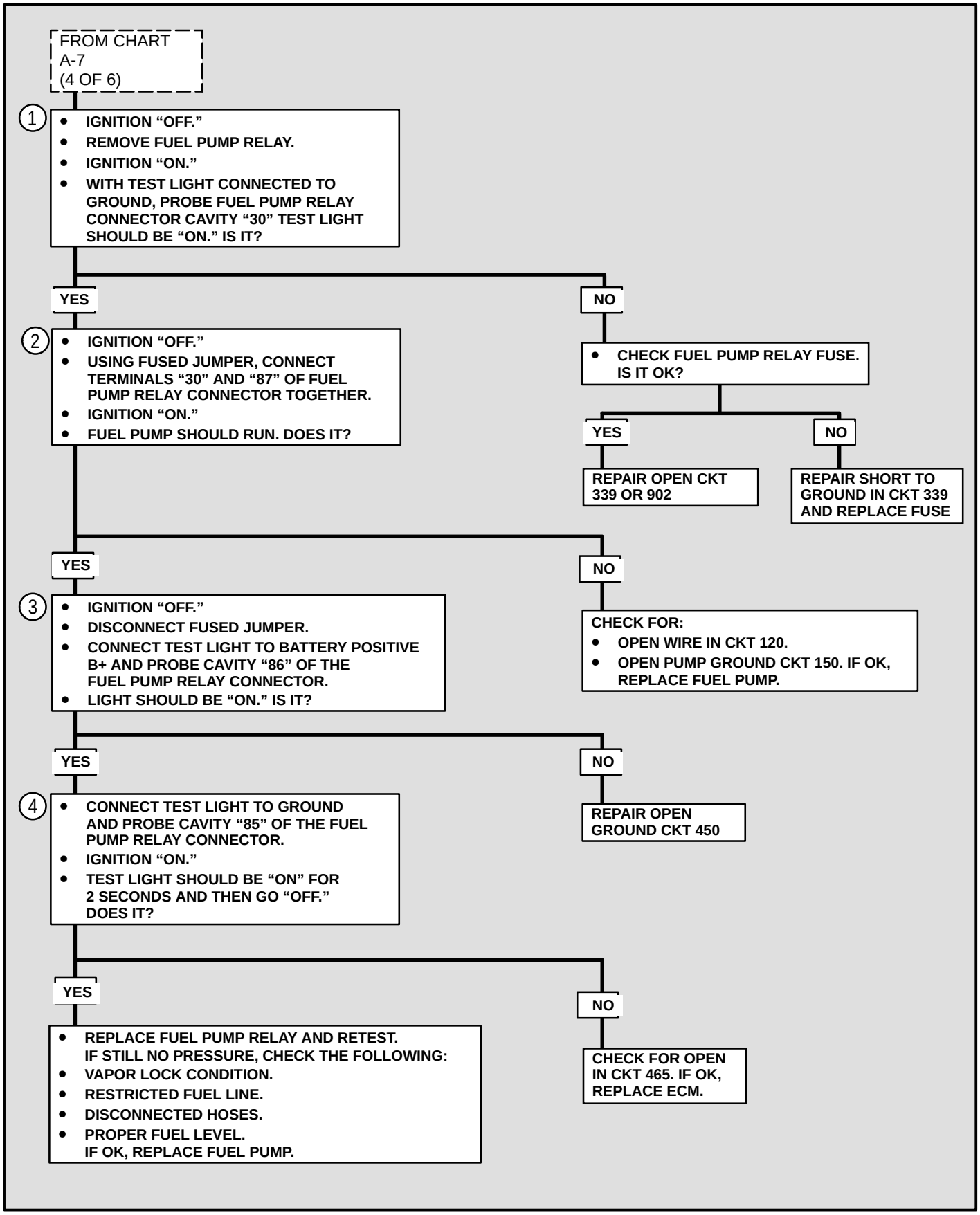
Multi-Port Injection Fuel System Diagnosis (Continued)
Chart A-7: (6 of 6)


FROM CHART A-7 (4 OF 6)
1
IGNITION "OFF."
REMOVE FUEL PUMP RELAY.
IGNITION "ON."
WITH TEST LIGHT CONNECTED TO GROUND, PROBE FUEL PUMP RELAY CONNECTOR CAVITY "30" TEST LIGHT SHOULD BE "ON." IS IT?
YES
NO
2
IGNITION "OFF."
USING FUSED JUMPER, CONNECT TERMINALS "30" AND "87" OF FUEL PUMP RELAY CONNECTOR TOGETHER.
IGNITION "ON."
FUEL PUMP SHOULD RUN. DOES IT?
CHECK FUEL PUMP RELAY FUSE. IS IT OK?
YES
NO
REPAIR OPEN CKT 339 OR 902
REPAIR SHORT TO GROUND IN CKT 339 AND REPLACE FUSE
YES
NO
3
IGNITION "OFF."
DISCONNECT FUSED JUMPER.
CONNECT TEST LIGHT TO BATTERY POSITIVE B+ AND PROBE CAVITY "86" OF THE FUEL PUMP RELAY CONNECTOR.
LIGHT SHOULD BE "ON." IS IT?
CHECK FOR:
OPEN WIRE IN CKT 120.
OPEN PUMP GROUND CKT 150. IF OK, REPLACE FUEL PUMP.
YES
NO
4
CONNECT TEST LIGHT TO GROUND AND PROBE CAVITY "85" OF THE FUEL PUMP RELAY CONNECTOR.
IGNITION "ON."
TEST LIGHT SHOULD BE "ON" FOR 2 SECONDS AND THEN GO "OFF." DOES IT?
REPAIR OPEN GROUND CKT 450
YES
NO
REPLACE FUEL PUMP RELAY AND RETEST. IF STILL NO PRESSURE, CHECK THE FOLLOWING:
VAPOR LOCK CONDITION.
RESTRICTED FUEL LINE.
DISCONNECTED HOSES.
PROPER FUEL LEVEL.
IF OK, REPLACE FUEL PUMP.
CHECK FOR OPEN IN CKT 465. IF OK, REPLACE ECM.

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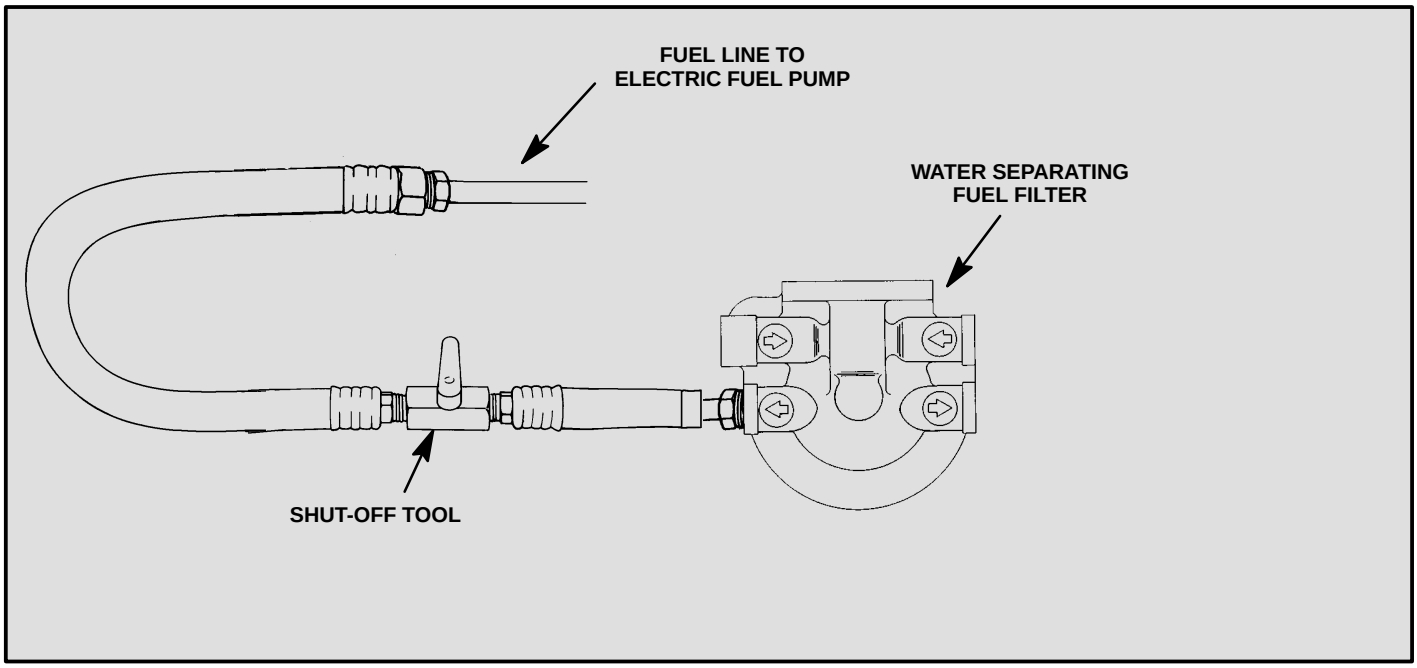
Throttle Body Injection Fuel System Diagnosis
Chart A-7 (1 of 6)



IMPORTANT: Check for contaminated fuel tank, stuck anti-siphon valve or fuel system vacuum leak anywhere before the electrical fuel pump and after the fuel pressure regulator.

CIRCUIT DESCRIPTION:

During engine cranking, the Engine Control Module (ECM) will turn ON the electric fuel pump. It will remain ON as long as the engine is cranking or running, and the ECM is receiving reference pulses. If there are no reference pulses, the ECM will shut OFF the fuel pump.

The pump will deliver fuel to the injectors and pressure regulator, where the system pressure is controlled to about 30 PSI (207 kPa) nominal. Excess fuel is then returned to the water separating fuel filter.

TEST DESCRIPTION:

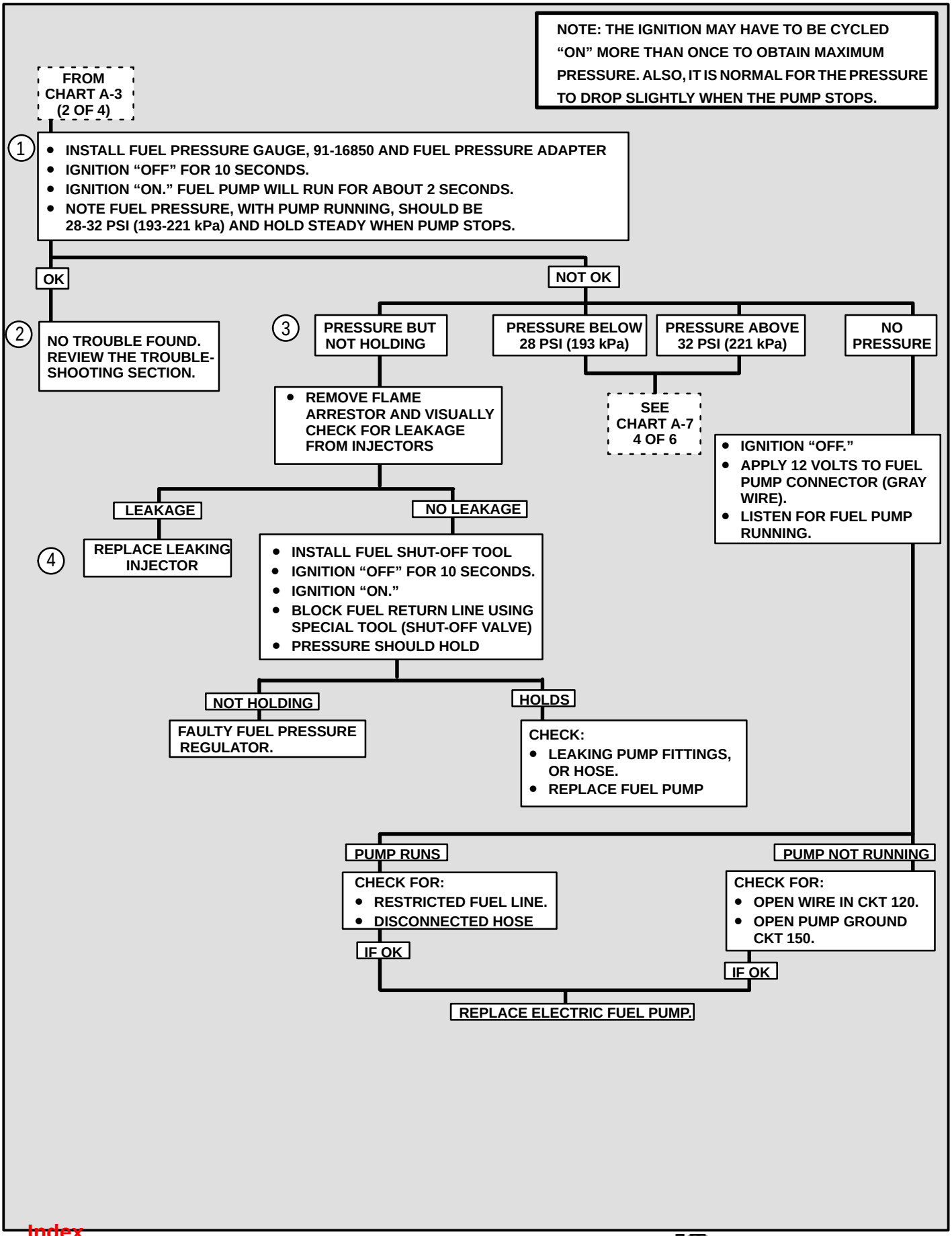
Number(s) below refer to circled number(s) on the diagnostic chart.

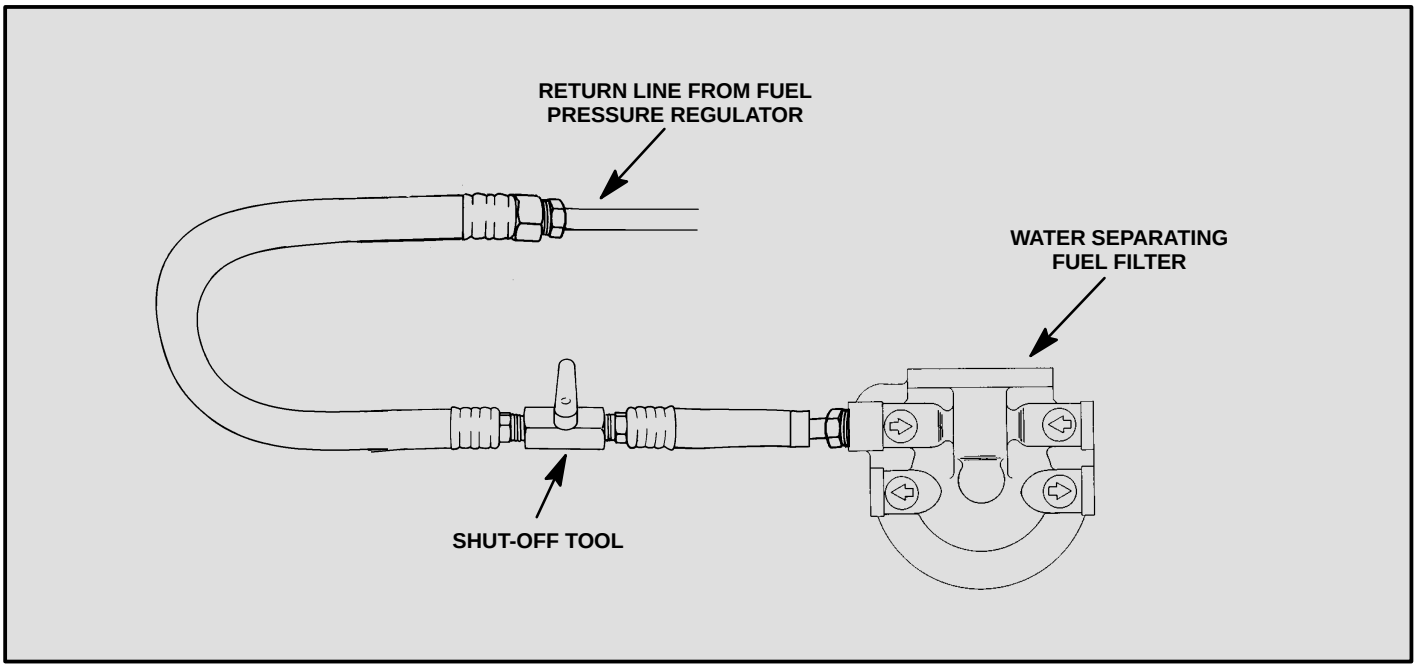
NOTE: *If pump does not run, check fuel pump relay and fuse.*

1. Install the fuel pressure adapter in-line at the throttle body.
2. Wrap a shop towel around the fuel pressure connector to absorb any small amount of fuel leakage that may occur when installing the gauge.

   Ignition ON, pump pressure should be 28-32 PSI (234-207 kPa). This pressure is controlled by spring pressure within the regulator assembly.
3. Pressure that leaks down is caused by one of the following:
   - Fuel pressure regulator valve leaking.
   - Injector(s) sticking open.
   - Check valve in fuel pump leaking.
4. An injector that is stuck open will leak or drip fuel into the plenum of intake manifold, which may saturate or foul spark plug(s). In order to determine which injector is leaking, remove the flame arrestor and observe both fuel injectors with “key on” and “engine off”.

Throttle Body Injection Fuel System Diagnosis (Continued)
Chart A-7: (2 of 6)


NOTE: THE IGNITION MAY HAVE TO BE CYCLED "ON" MORE THAN ONCE TO OBTAIN MAXIMUM PRESSURE. ALSO, IT IS NORMAL FOR THE PRESSURE TO DROP SLIGHTLY WHEN THE PUMP STOPS.
FROM CHART A-3 (2 OF 4)
1
INSTALL FUEL PRESSURE GAUGE, 91-16850 AND FUEL PRESSURE ADAPTER
IGNITION "OFF" FOR 10 SECONDS.
IGNITION "ON." FUEL PUMP WILL RUN FOR ABOUT 2 SECONDS.
NOTE FUEL PRESSURE, WITH PUMP RUNNING, SHOULD BE 28-32 PSI (193-221 kPa) AND HOLD STEADY WHEN PUMP STOPS.
OK
NOT OK
2
NO TROUBLE FOUND. REVIEW THE TROUBLE-SHOOTING SECTION.
3
PRESSURE BUT NOT HOLDING
PRESSURE BELOW 28 PSI (193 kPa)
PRESSURE ABOVE 32 PSI (221 kPa)
NO PRESSURE
REMOVE FLAME ARRESTOR AND VISUALLY CHECK FOR LEAKAGE FROM INJECTORS
SEE CHART A-7 4 OF 6
IGNITION "OFF."
APPLY 12 VOLTS TO FUEL PUMP CONNECTOR (GRAY WIRE).
LISTEN FOR FUEL PUMP RUNNING.
LEAKAGE
NO LEAKAGE
4
REPLACE LEAKING INJECTOR
INSTALL FUEL SHUT-OFF TOOL
IGNITION "OFF" FOR 10 SECONDS.
IGNITION "ON."
BLOCK FUEL RETURN LINE USING SPECIAL TOOL (SHUT-OFF VALVE)
PRESSURE SHOULD HOLD
NOT HOLDING
HOLDS
FAULTY FUEL PRESSURE REGULATOR.
CHECK:
LEAKING PUMP FITTINGS, OR HOSE.
REPLACE FUEL PUMP
PUMP RUNS
PUMP NOT RUNNING
CHECK FOR:
RESTRICTED FUEL LINE.
DISCONNECTED HOSE
CHECK FOR:
OPEN WIRE IN CKT 120.
OPEN PUMP GROUND CKT 150.
IF OK
IF OK
REPLACE ELECTRIC FUEL PUMP.



IMPORTANT: Check for contaminated fuel tank, stuck anti-siphon valve or fuel system vacuum leak anywhere before the electrical fuel pump and after the fuel pressure regulator.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Pressure less than 28 PSI (193 kPa) falls into two areas:

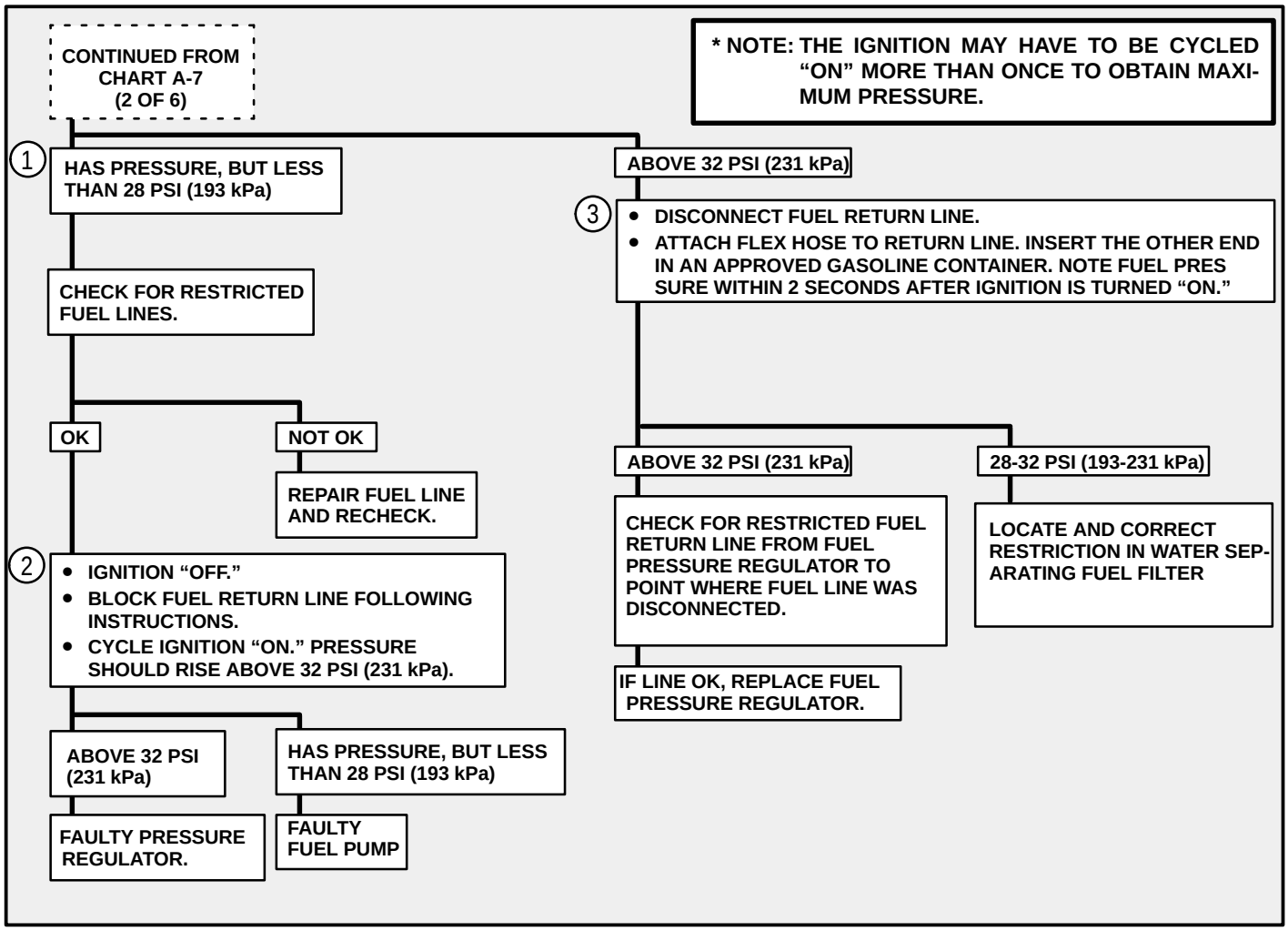
- Regulated pressure less than 28 PSI (193 kPa). The system will be running lean. Also, hard starting when cold and overall poor performance will be noticed.
- Restricted flow causing pressure drop. Normally, an engine with a fuel pressure of less than 24 PSI (165 kPa) at idle will not be driveable. However, if the pressure drop occurs only while underway, the engine will surge then stop running as pressure begins to drop rapidly. This is most likely caused by a restricted fuel line or plugged water separating fuel filter.

2. Restricting the fuel return line (Shut-Off Valve) allows the fuel pressure to build above regulated pressure. With battery voltage applied to the fuel pump, pressure should rise to 60 PSI (414 kPa) as the fuel return hose is shut off with special tool.

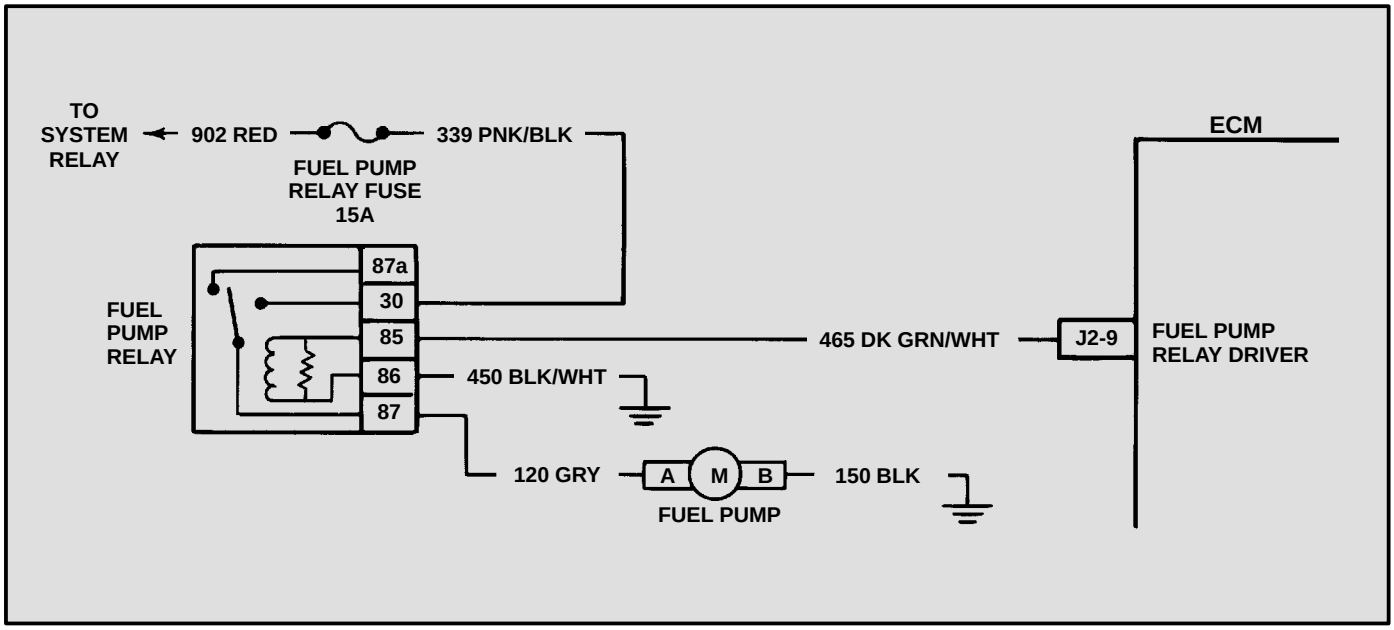
NOTE: *Do not allow fuel pressure to exceed 60 PSI (414 kPa); damage to the pressure regulator may result.*

3. This test determines if the high fuel pressure is due to a restricted fuel return line or a pressure regulator problem.

Throttle Body Injection Fuel System Diagnosis (Continued)
Chart A-7: (4 of 6)


CONTINUED FROM CHART A-7 (2 OF 6)
* NOTE: THE IGNITION MAY HAVE TO BE CYCLED "ON" MORE THAN ONCE TO OBTAIN MAXIMUM PRESSURE.
1
HAS PRESSURE, BUT LESS THAN 28 PSI (193 kPa)
CHECK FOR RESTRICTED FUEL LINES.
OK
NOT OK
REPAIR FUEL LINE AND RECHECK.
2
IGNITION "OFF."
BLOCK FUEL RETURN LINE FOLLOWING INSTRUCTIONS.
CYCLE IGNITION "ON." PRESSURE SHOULD RISE ABOVE 32 PSI (231 kPa).
ABOVE 32 PSI (231 kPa)
FAULTY PRESSURE REGULATOR.
HAS PRESSURE, BUT LESS THAN 28 PSI (193 kPa)
FAULTY FUEL PUMP
ABOVE 32 PSI (231 kPa)
3
DISCONNECT FUEL RETURN LINE.
ATTACH FLEX HOSE TO RETURN LINE. INSERT THE OTHER END IN AN APPROVED GASOLINE CONTAINER. NOTE FUEL PRESSURE WITHIN 2 SECONDS AFTER IGNITION IS TURNED "ON."
ABOVE 32 PSI (231 kPa)
CHECK FOR RESTRICTED FUEL RETURN LINE FROM FUEL PRESSURE REGULATOR TO POINT WHERE FUEL LINE WAS DISCONNECTED.
IF LINE OK, REPLACE FUEL PRESSURE REGULATOR.
28-32 PSI (193-231 kPa)
LOCATE AND CORRECT RESTRICTION IN WATER SEPARATING FUEL FILTER

Throttle Body Injection Fuel System Diagnosis (Continued)
Chart A-7 (5 of 6)



TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step checks if there is power to the fuel pump relay.
2. Bypassing the relay circuit should cause the fuel pump to run. This step should identify if the fault is in the relay or in the fuel pump circuit.
3. This step checks if there is an open in the ground circuit.
4. This step checks if the ECM is functioning properly.

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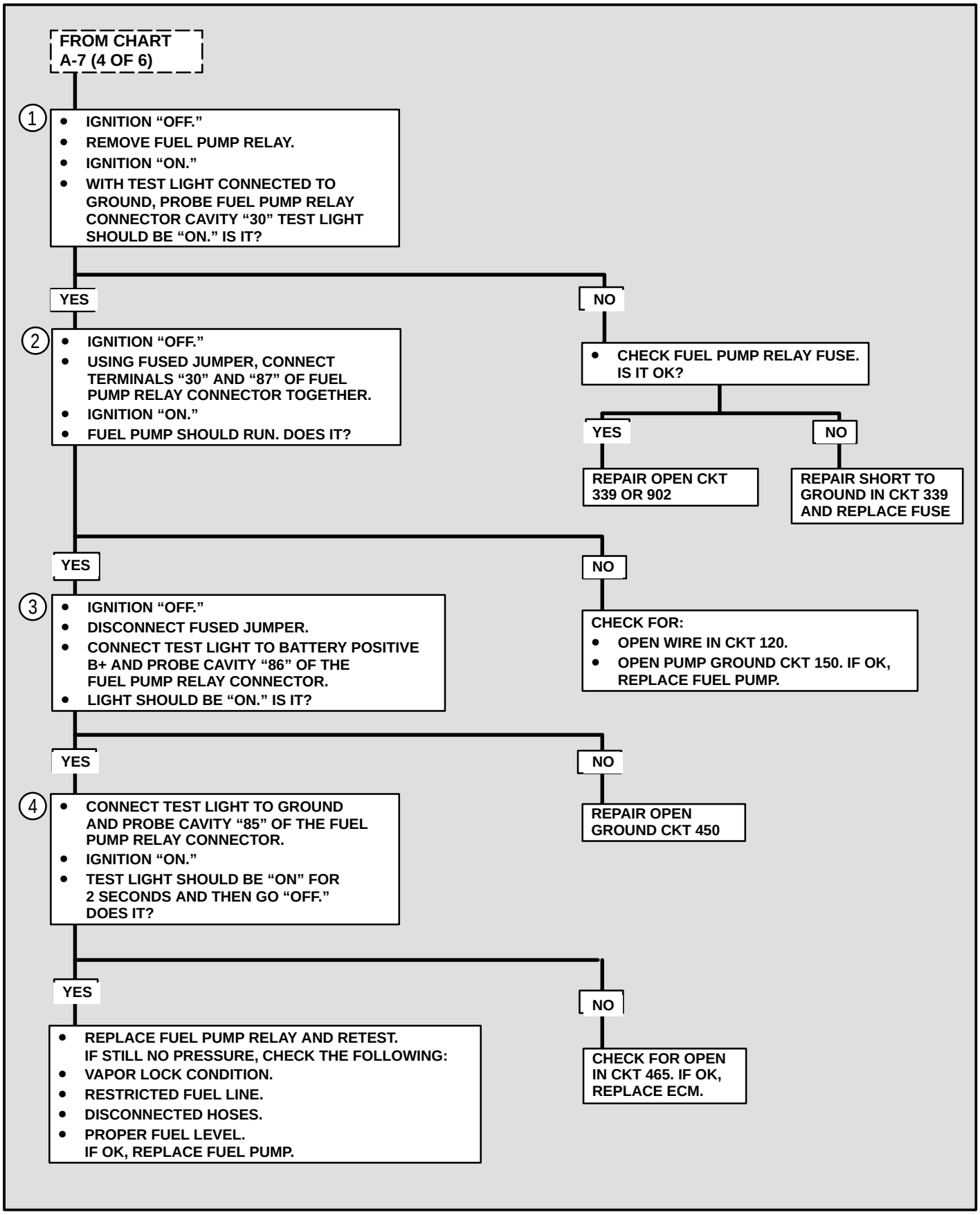
Throttle Body Injection Fuel System Diagnosis (Continued)
Chart A-7: (6 of 6)


FROM CHART A-7 (4 OF 6)
1
IGNITION "OFF."
REMOVE FUEL PUMP RELAY.
IGNITION "ON."
WITH TEST LIGHT CONNECTED TO GROUND, PROBE FUEL PUMP RELAY CONNECTOR CAVITY "30" TEST LIGHT SHOULD BE "ON." IS IT?
YES
NO
2
IGNITION "OFF."
USING FUSED JUMPER, CONNECT TERMINALS "30" AND "87" OF FUEL PUMP RELAY CONNECTOR TOGETHER.
IGNITION "ON."
FUEL PUMP SHOULD RUN. DOES IT?
CHECK FUEL PUMP RELAY FUSE. IS IT OK?
YES
NO
REPAIR OPEN CKT 339 OR 902
REPAIR SHORT TO GROUND IN CKT 339 AND REPLACE FUSE
YES
NO
3
IGNITION "OFF."
DISCONNECT FUSED JUMPER.
CONNECT TEST LIGHT TO BATTERY POSITIVE B+ AND PROBE CAVITY "86" OF THE FUEL PUMP RELAY CONNECTOR.
LIGHT SHOULD BE "ON." IS IT?
CHECK FOR:
OPEN WIRE IN CKT 120.
OPEN PUMP GROUND CKT 150. IF OK, REPLACE FUEL PUMP.
YES
NO
4
CONNECT TEST LIGHT TO GROUND AND PROBE CAVITY "85" OF THE FUEL PUMP RELAY CONNECTOR.
IGNITION "ON."
TEST LIGHT SHOULD BE "ON" FOR 2 SECONDS AND THEN GO "OFF." DOES IT?
REPAIR OPEN GROUND CKT 450
YES
NO
REPLACE FUEL PUMP RELAY AND RETEST. IF STILL NO PRESSURE, CHECK THE FOLLOWING:
VAPOR LOCK CONDITION.
RESTRICTED FUEL LINE.
DISCONNECTED HOSES.
PROPER FUEL LEVEL.
IF OK, REPLACE FUEL PUMP.
CHECK FOR OPEN IN CKT 465. IF OK, REPLACE ECM.

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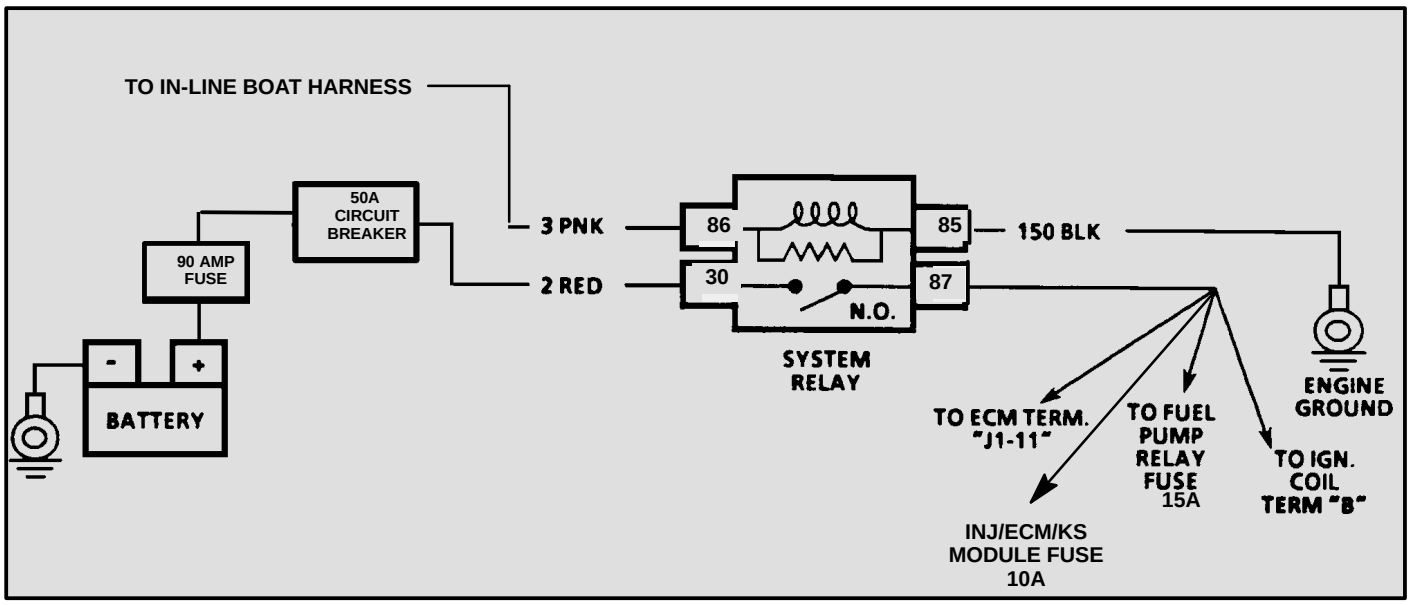
EFI System/Ignition Relay Check
(1 of 2)



CIRCUIT DESCRIPTION:

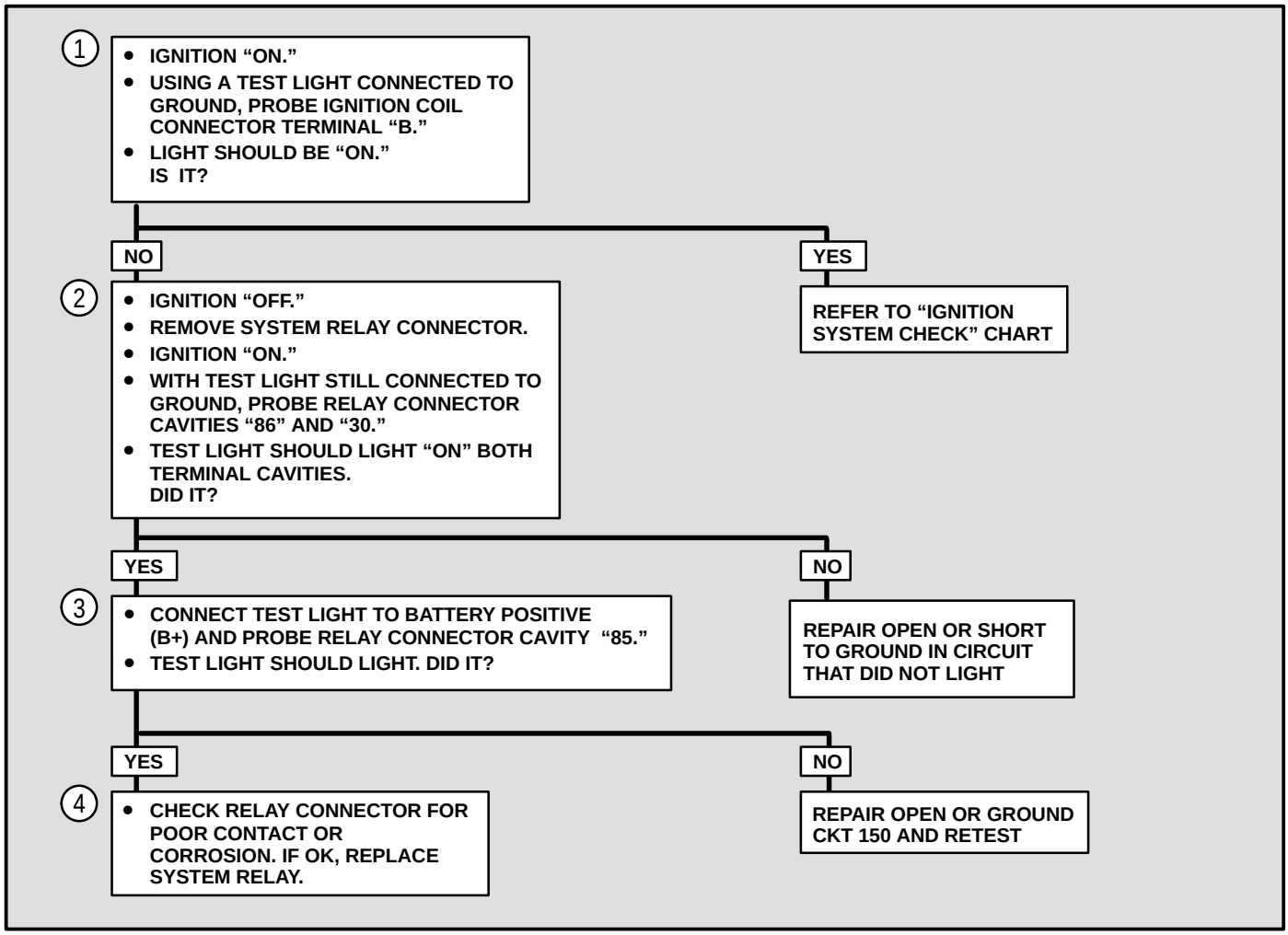
Battery voltage is constantly supplied to terminal 30 of the system relay. When the ignition switch is moved to the run position, battery voltage is supplied to terminal 86 of the system relay. The pull-in coil is then energized, creating a magnetic field which closes the contacts of the system relay. Voltage and current are then supplied to the ignition coil, injectors, ECM and fuel pump relay fuse through terminal 87 of the system relay.

TEST DESCRIPTION:

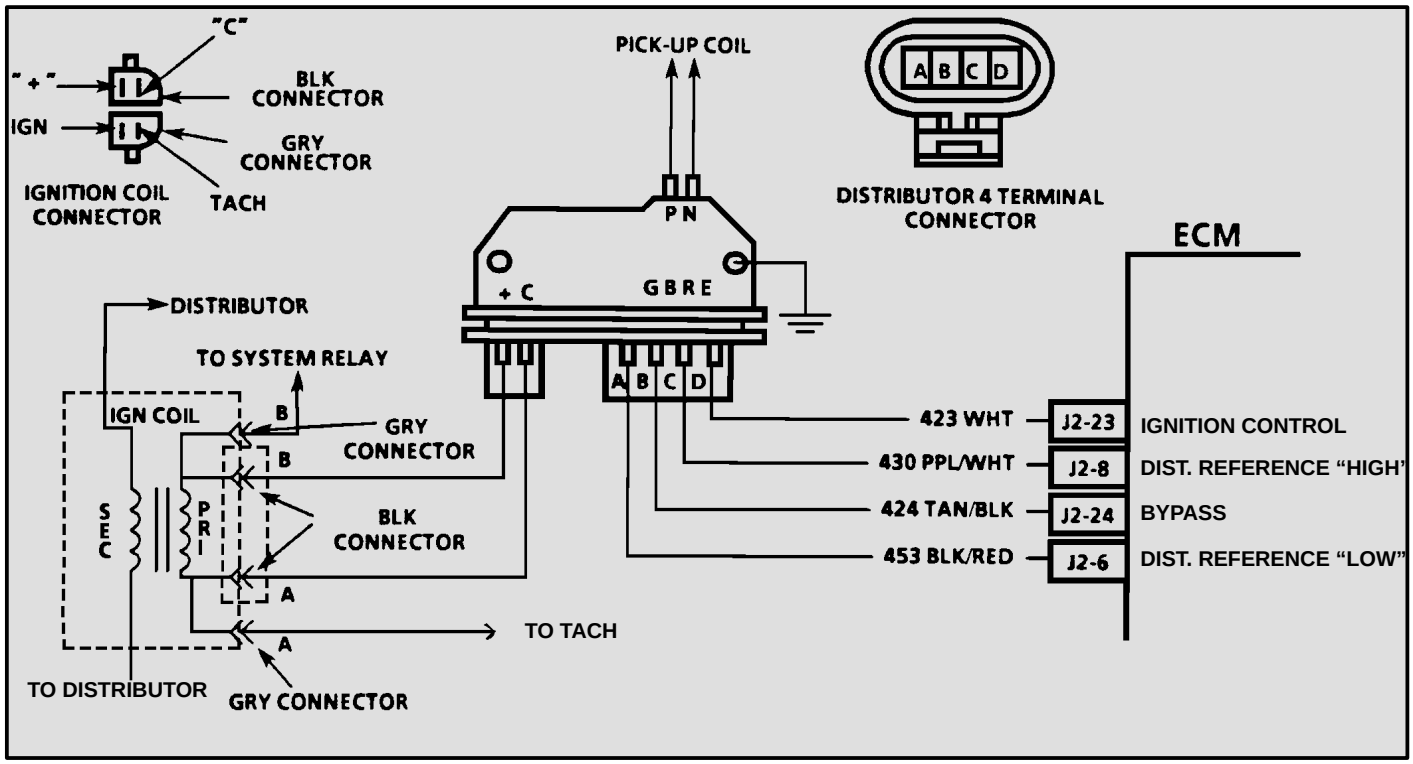
Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step identifies if the relay is functioning properly. If a fault in the relay circuit were present, voltage would not be available at terminal B of the ignition coil.
2. This step ensures that battery and ignition voltage are available at the relay. An open or shorted condition in either supply would cause the relay not to operate.
3. This step ensures that a good ground exists to terminal 85 of the system relay. An open ground to this terminal would not allow current to flow through the pull-in coil.
4. At this point, the circuits leading to the relay have been checked, and a careful visual inspection of the relay terminals should be preformed prior to replacement of the system relay.

EFI System / Ignition Relay Check (Continued)
(2 of 2)


1
IGNITION "ON."
USING A TEST LIGHT CONNECTED TO GROUND, PROBE IGNITION COIL CONNECTOR TERMINAL "B."
LIGHT SHOULD BE "ON."
IS IT?
NO
YES
REFER TO "IGNITION SYSTEM CHECK" CHART
2
IGNITION "OFF."
REMOVE SYSTEM RELAY CONNECTOR.
IGNITION "ON."
WITH TEST LIGHT STILL CONNECTED TO GROUND, PROBE RELAY CONNECTOR CAVITIES "86" AND "30."
TEST LIGHT SHOULD LIGHT "ON" BOTH TERMINAL CAVITIES.
DID IT?
YES
NO
3
CONNECT TEST LIGHT TO BATTERY POSITIVE (B+) AND PROBE RELAY CONNECTOR CAVITY "85."
TEST LIGHT SHOULD LIGHT. DID IT?
REPAIR OPEN OR SHORT TO GROUND IN CIRCUIT THAT DID NOT LIGHT
YES
NO
4
CHECK RELAY CONNECTOR FOR POOR CONTACT OR CORROSION. IF OK, REPLACE SYSTEM RELAY.
REPAIR OPEN OR GROUND CKT 150 AND RETEST

Ignition System Check
(1 of 2)



TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Two spark plug wires are checked, to ensure that an open is not present in a spark plug wire.

   If spark occurs with Ignition Control (IC) connector disconnected, magnetic field output is too low for Ignition Control (IC) operation.

2. A spark indicates the problem must be the distributor cap or rotor.

3. Normally, there should be battery voltage at the "C" and "+" terminals. Low voltage would indicate an open or a high resistance circuit from the distributor to the coil or ignition switch. If "C" terminal voltage was low, but "+" terminal voltage is 10 volts or more, circuit from "C" terminal to ignition coil or ignition coil primary winding is open.

4. Checks for a shorted module or grounded circuit from the ignition coil to the module. The distributor module should be turned OFF, so normal voltage should be about 12 volts.

   If the module is turned ON, the voltage would be low, but above 1 volt. This could cause the ignition coil to fail from excessive heat.

   With an open ignition coil primary winding, a small amount of voltage will leak through the module from the Battery Positive (B+) to the "Tach" terminal.

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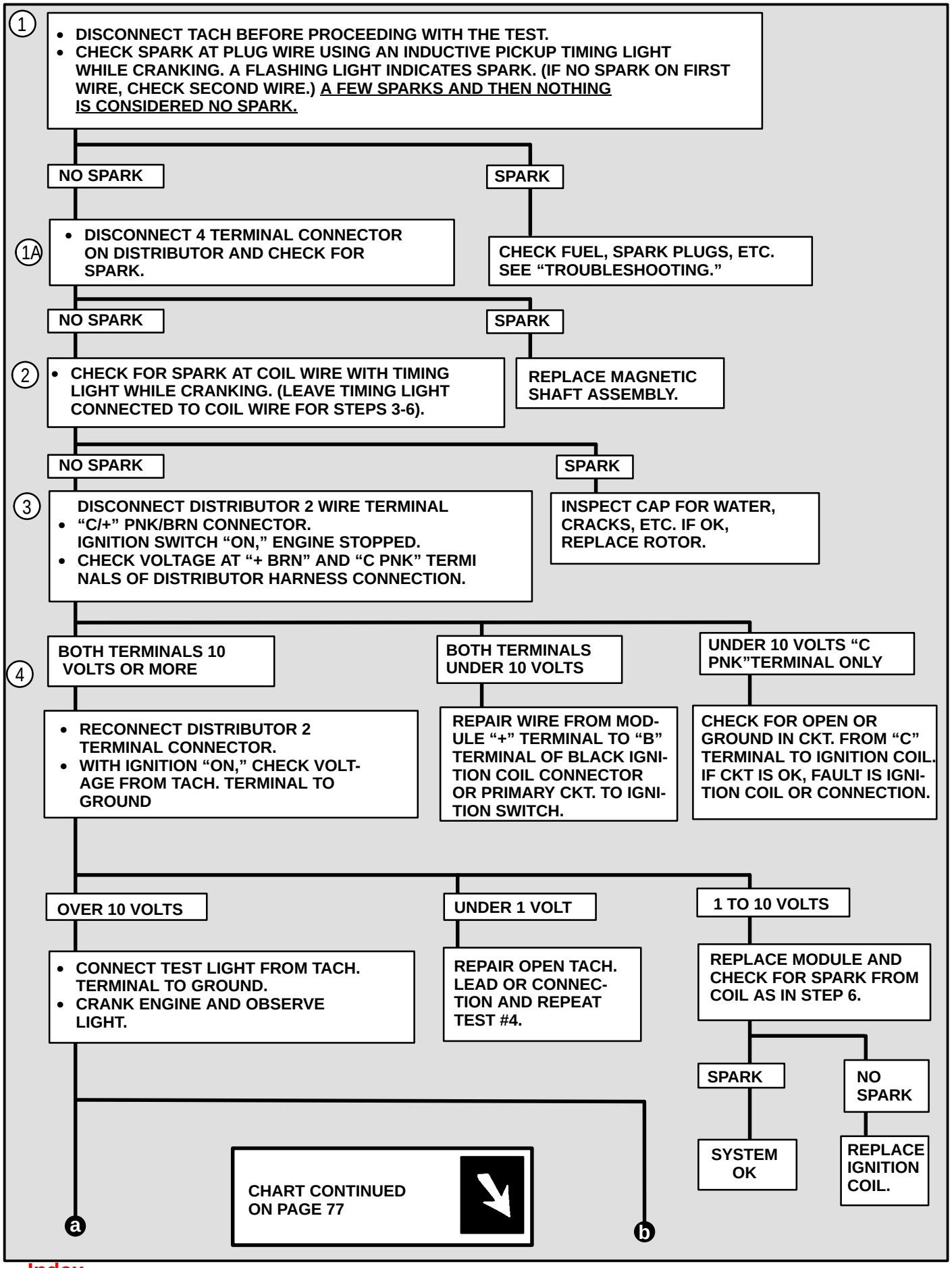
Ignition System Check(1 of 2)


1
DISCONNECT TACH BEFORE PROCEEDING WITH THE TEST.
CHECK SPARK AT PLUG WIRE USING AN INDUCTIVE PICKUP TIMING LIGHT WHILE CRANKING. A FLASHING LIGHT INDICATES SPARK. (IF NO SPARK ON FIRST WIRE, CHECK SECOND WIRE.) A FEW SPARKS AND THEN NOTHING IS CONSIDERED NO SPARK.
NO SPARK
SPARK
1A
DISCONNECT 4 TERMINAL CONNECTOR ON DISTRIBUTOR AND CHECK FOR SPARK.
CHECK FUEL, SPARK PLUGS, ETC. SEE "TROUBLESHOOTING."
NO SPARK
SPARK
2
CHECK FOR SPARK AT COIL WIRE WITH TIMING LIGHT WHILE CRANKING. (LEAVE TIMING LIGHT CONNECTED TO COIL WIRE FOR STEPS 3-6).
REPLACE MAGNETIC SHAFT ASSEMBLY.
NO SPARK
SPARK
3
DISCONNECT DISTRIBUTOR 2 WIRE TERMINAL "C/+" PNK/BRN CONNECTOR. IGNITION SWITCH "ON," ENGINE STOPPED.
CHECK VOLTAGE AT "+ BRN" AND "C PNK" TERMINALS OF DISTRIBUTOR HARNESS CONNECTION.
INSPECT CAP FOR WATER, CRACKS, ETC. IF OK, REPLACE ROTOR.
4
BOTH TERMINALS 10 VOLTS OR MORE
BOTH TERMINALS UNDER 10 VOLTS
UNDER 10 VOLTS "C PNK"TERMINAL ONLY
RECONNECT DISTRIBUTOR 2 TERMINAL CONNECTOR.
WITH IGNITION "ON," CHECK VOLTAGE FROM TACH. TERMINAL TO GROUND
REPAIR WIRE FROM MODULE "+" TERMINAL TO "B" TERMINAL OF BLACK IGNITION COIL CONNECTOR OR PRIMARY CKT. TO IGNITION SWITCH.
CHECK FOR OPEN OR GROUND IN CKT. FROM "C" TERMINAL TO IGNITION COIL. IF CKT IS OK, FAULT IS IGNITION COIL OR CONNECTION.
OVER 10 VOLTS
UNDER 1 VOLT
1 TO 10 VOLTS
CONNECT TEST LIGHT FROM TACH. TERMINAL TO GROUND.
CRANK ENGINE AND OBSERVE LIGHT.
REPAIR OPEN TACH. LEAD OR CONNECTION AND REPEAT TEST #4.
REPLACE MODULE AND CHECK FOR SPARK FROM COIL AS IN STEP 6.
SPARK
NO SPARK
SYSTEM OK
REPLACE IGNITION COIL.
CHART CONTINUED ON PAGE 77
a
b

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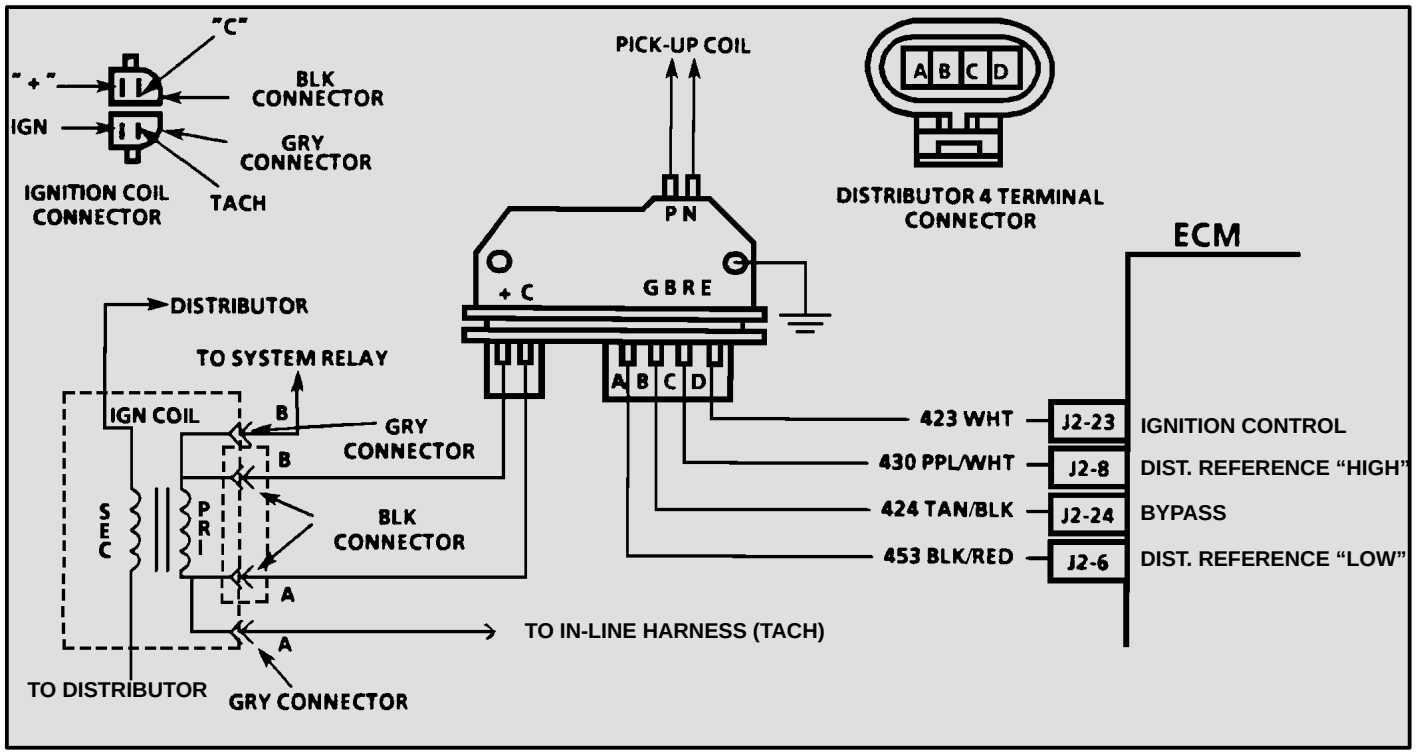
Ignition System Check
(2 of 2)



TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

5. Applying a voltage (1.5 to 8 volts) to module terminal "P" should turn the module ON and the "Tach" terminal voltage should drop to about 7-9 volts. This test will determine whether the module or coil is faulty or if the pick-up coil is not generating the proper signal to turn the module "ON." This test can be performed by using a DC battery with a rating of 1.5 to 8 volts. The use of the test light is mainly to allow the "P" terminal to be probed more easily. Some digital multimeter can also be used to trigger the module by selecting ohms, usually the diode position. In this position, the meter may have a voltage across its terminals which can be used to trigger the module. The voltage in the ohms position can be checked by using a second meter or by checking the manufacturer's specification of the tool being used.
6. This should turn OFF the module and cause a spark. If no spark occurs, the fault is most likely in the ignition coil because most module problems would have been found before this point in the procedure.

Ignition System Check (2 of 2)

CHART CONTINUED FROM PAGE 75

a

LIGHT ON STEADY

b

LIGHT BLINKS

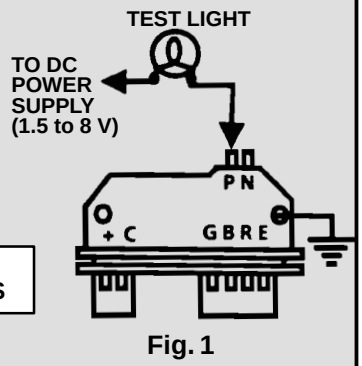


Fig. 1

5

- DISCONNECT DISTRIBUTOR 4 TERMINAL CONNECTOR.
- REMOVE DISTRIBUTOR CAP.
- DISCONNECT PICK-UP COIL CONNECTOR FROM MODULE.
- CONNECT VOLTMETER FROM TACH. TERMINAL TO GROUND.
- IGNITION "ON."
- INSULATE A TEST LIGHT PROBE TO 1/4, FROM TIP AND NOTE VOLTAGE, AS TEST LIGHT IS MOMENTARILY CONNECTED FROM A VOLTAGE SOURCE (1.5 TO 8 V) TO MODULE TERMINAL "P" (CHART 1 OF 2 PAGE 78).

REPLACE IGNITION COIL AND RECHECK FOR SPARK WITH TIMING LIGHT. IF STILL NO SPARK, REINSTALL ORIGINAL COIL AND REPLACE DISTRIBUTOR MODULE.

VOLTAGE DROPS

NO DROP IN VOLTAGE

6

- CHECK FOR SPARK FROM COIL WIRE WITH TIMING LIGHT AS TEST LIGHT IS REMOVED FROM MODULE TERMINAL

CHECK MODULE GROUND. IF OK, REPLACE MODULE.

NO SPARK

SPARK

- REPLACE IGNITION COIL AND REPEAT STEP 5.

- IS ROTATING POLE PIECE STILL MAGNETIZED?

NO SPARK

SPARK

YES

NO

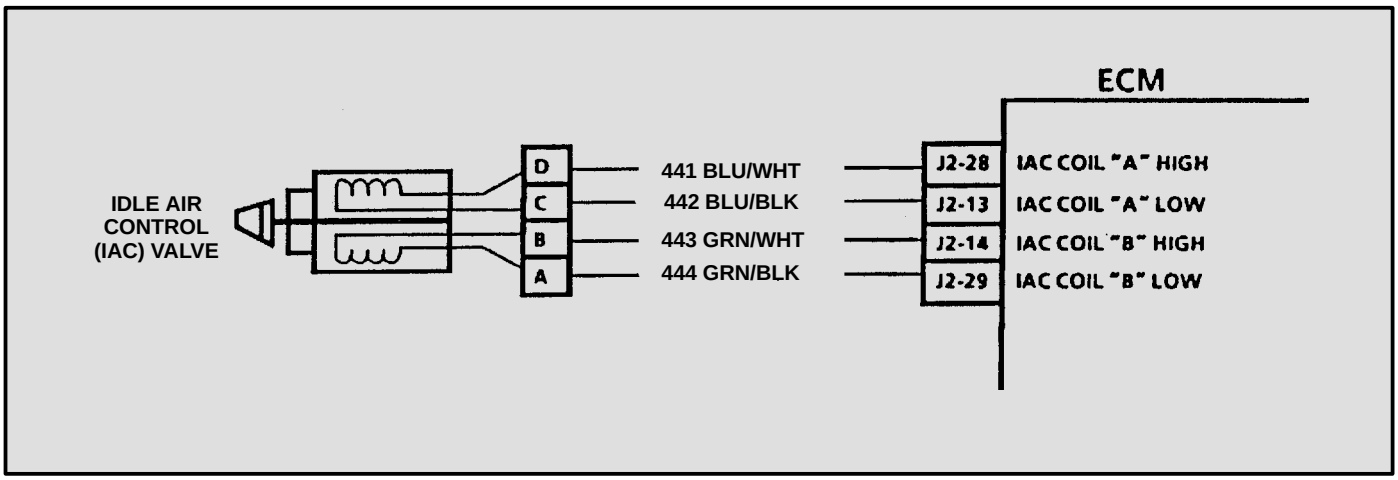
IGNITION COIL REMOVED IS OK, REINSTALL COIL AND CHECK COIL WIRE FROM DIST. CAP. IF OK, REPLACE DISTRIBUTOR MODULE.

SYSTEM OK

CHECK PICK-UP COIL OR CONNECTIONS (COIL RESISTANCE SHOULD BE 500-1500 OHMS AND NOT GROUNDED.)

REPLACE POLE PIECE AND SHAFT ASSEMBLY.

Idle Air Control (IAC) Functional Test
(1 of 2)



CIRCUIT DESCRIPTION:

The ECM controls idle speed to a calculated, "desired" RPM based on sensor inputs and actual engine RPM, determined by the time between successive ignition reference pulses from the ignition module. The ECM uses four circuits to move an Idle Air Control (IAC) valve, which allows varying amounts of air flow into the intake manifold, controlling idle speed.

IMPORTANT: Improper IAC readings or improper idle speed can result from other faults ie: flooding VST, fouled spark plugs, bad sensors. These items should be in proper working order to ensure correct diagnosis.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the functional check chart.

1. This step determines if the IAC valve is functioning properly.
2. This step determines if the circuitry or the IAC valve is faulty.

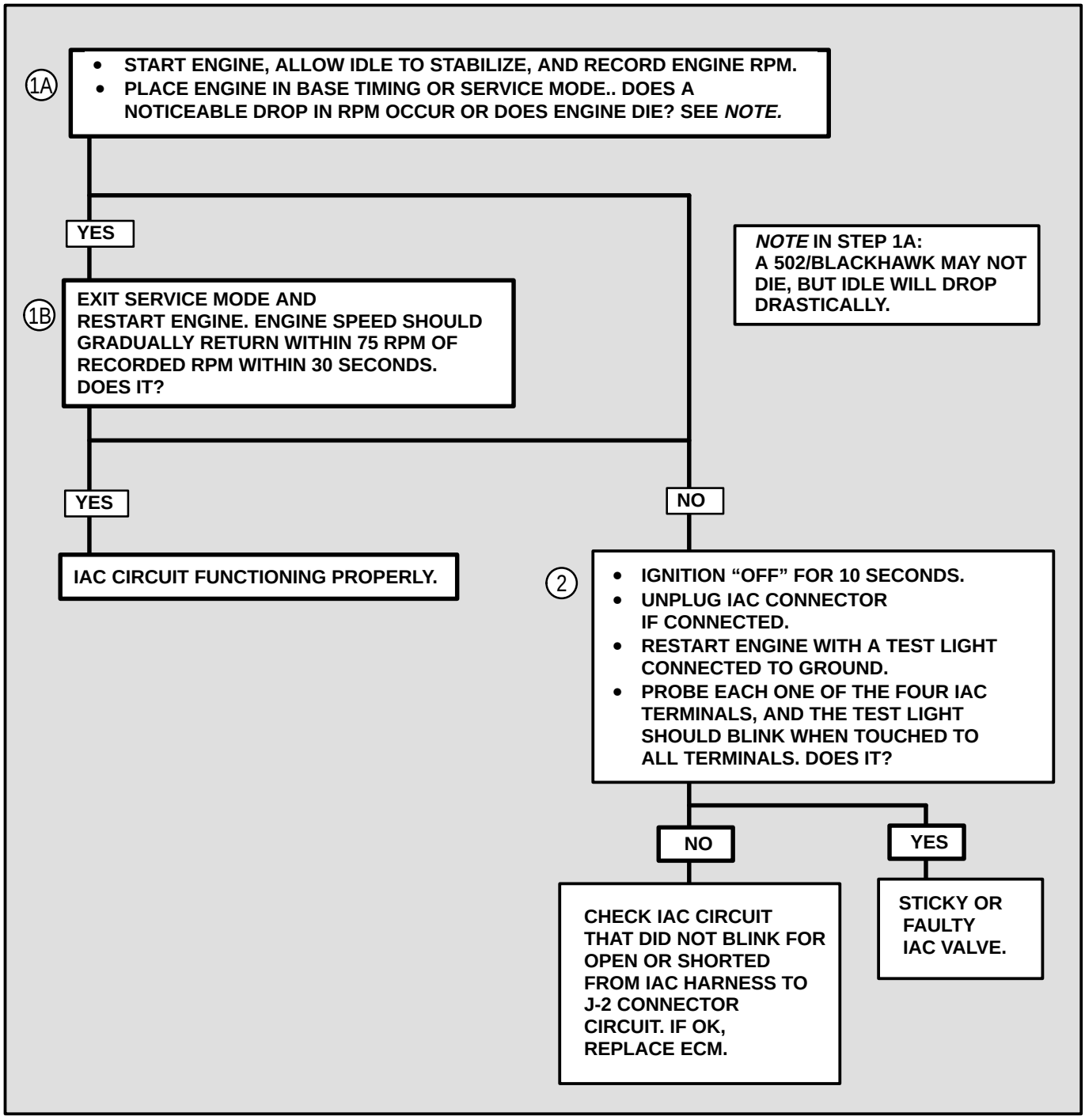
DIAGNOSTIC AIDS:

Check for vacuum leaks, unconnected or brittle vacuum hoses, cuts, etc. Examine manifold and throttle body gaskets for proper seal. Check for cracked intake manifold/plenum. Check open, shorts, or poor connections to IAC valve in CKTs 441, 442, 443 and 444.

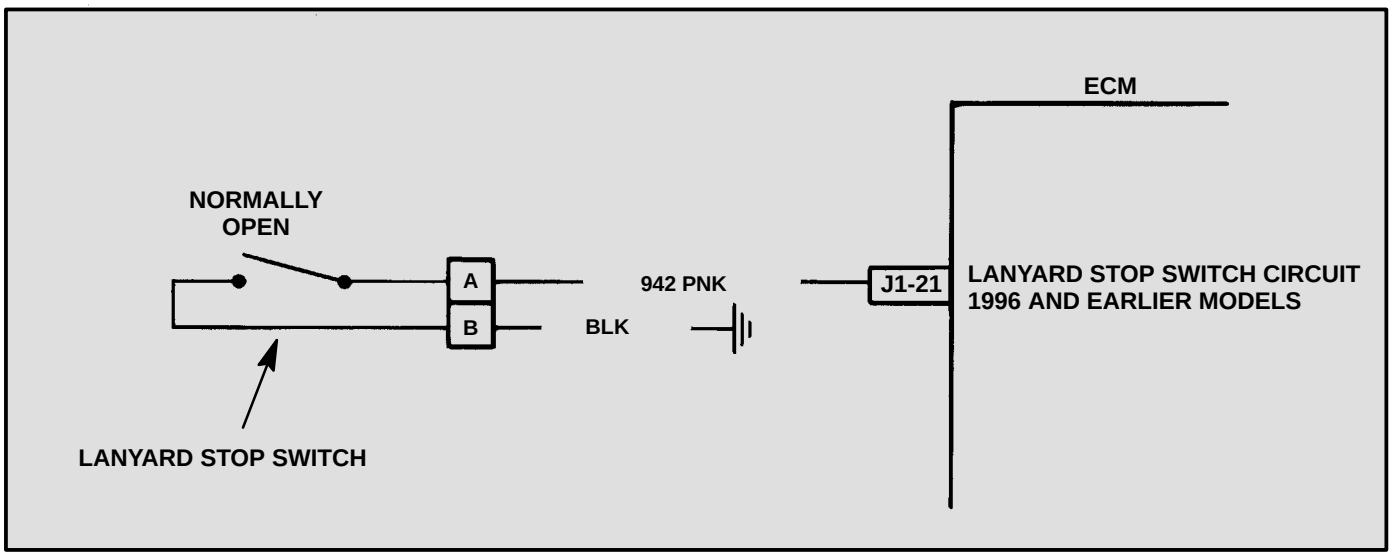
An open, short, or poor connection in CKTs 441, 442, 443, or 444 will result in improper idle control and may cause improper idle.

An IAC valve which is stopped and cannot respond to the ECM, a throttle stop screw which has been tampered with, or a damaged throttle body or linkage could cause improper idle.

Idle Air Control Functional Test
(2 of 2)


1A
START ENGINE, ALLOW IDLE TO STABILIZE, AND RECORD ENGINE RPM.
PLACE ENGINE IN BASE TIMING OR SERVICE MODE.. DOES A NOTICEABLE DROP IN RPM OCCUR OR DOES ENGINE DIE? SEE NOTE.
YES
NOTE IN STEP 1A:
A 502/BLACKHAWK MAY NOT DIE, BUT IDLE WILL DROP DRASTICALLY.
1B
EXIT SERVICE MODE AND RESTART ENGINE. ENGINE SPEED SHOULD GRADUALLY RETURN WITHIN 75 RPM OF RECORDED RPM WITHIN 30 SECONDS. DOES IT?
YES
NO
IAC CIRCUIT FUNCTIONING PROPERLY.
2
IGNITION "OFF" FOR 10 SECONDS.
UNPLUG IAC CONNECTOR IF CONNECTED.
RESTART ENGINE WITH A TEST LIGHT CONNECTED TO GROUND.
PROBE EACH ONE OF THE FOUR IAC TERMINALS, AND THE TEST LIGHT SHOULD BLINK WHEN TOUCHED TO ALL TERMINALS. DOES IT?
NO
YES
CHECK IAC CIRCUIT THAT DID NOT BLINK FOR OPEN OR SHORTED FROM IAC HARNESS TO J-2 CONNECTOR CIRCUIT. IF OK, REPLACE ECM.
STICKY OR FAULTY IAC VALVE.

Lanyard Stop Circuit Check (Emergency Stop) Circuit Check (1 of 2)



NOTE: *Some models are no longer equipped with this option in the wiring harness. Connection of the lanyard stop switch (if equipped) is performed at the instrument panel.*

CIRCUIT DESCRIPTION:

The Lanyard Stop circuit is a safety feature incorporated in boats to stop the engine in the event that the operator is removed from a safe control position during normal operation. The Lanyard Stop switch is a normally open switch that is physically connected to the operator by a tether. In the event that the operator is removed from a control position, the tether connected to the switch will be pulled out, closing the switch. This information from the Lanyard Stop switch will then be used by the ECM to cease engine operation until the position of the switch is restored to its normally open position and the ignition key switch has been cycled.

TEST DESCRIPTION:

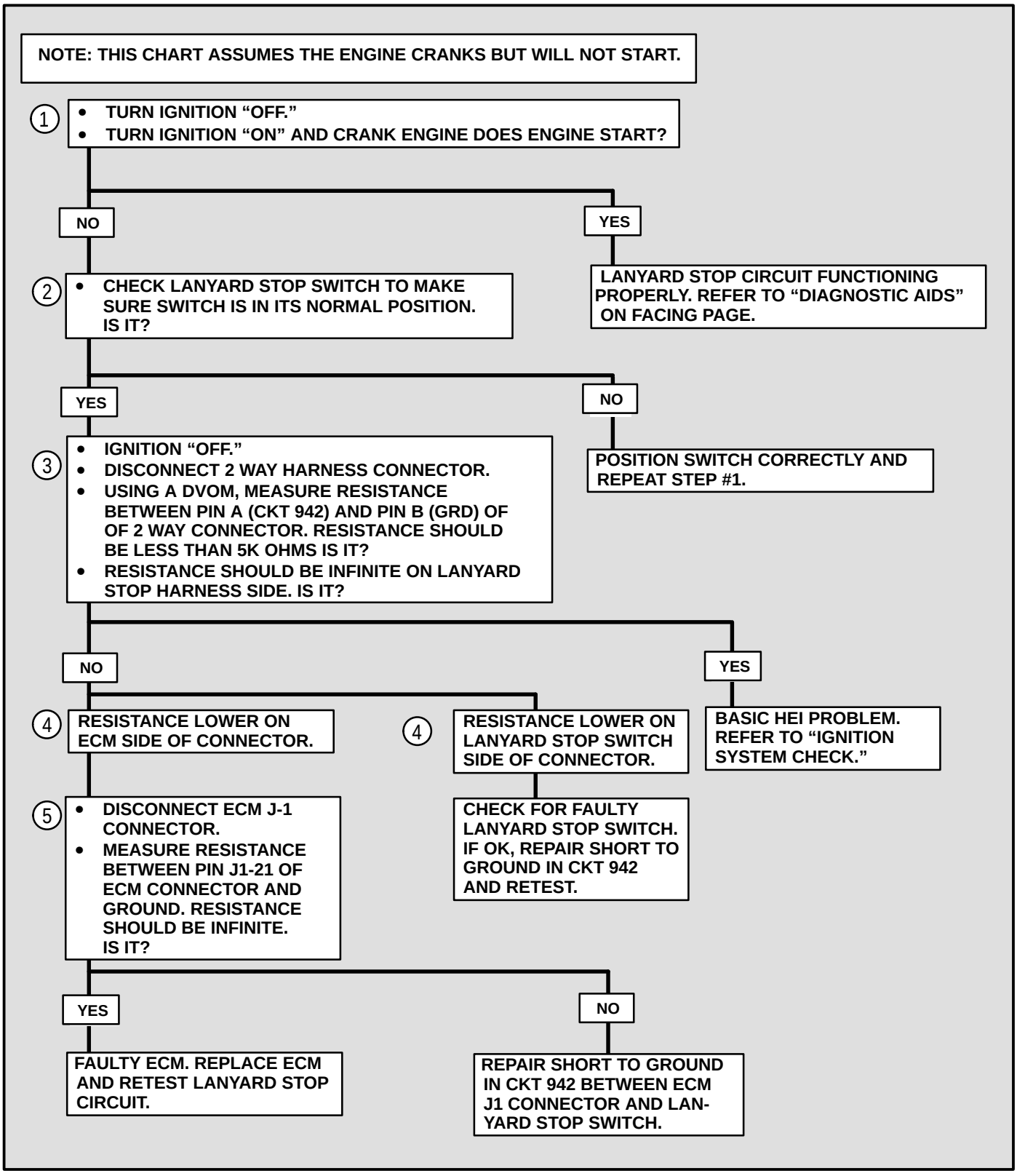
1. If a Lanyard Stop was recognized by the ECM, cycling the ignition will clear the Lanyard Stop condition in the ECM.
2. This step checks to see if the Lanyard Stop switch is in the correct position. If the switch is closed, a Lanyard Stop condition will exist.
3. This step checks for Lanyard Stop switch or Lanyard Stop circuitry that is shorted to ground.
4. This step identifies which half of the circuitry is shorted to ground; i.e., ECM side or switch side.
5. This step identifies if the circuitry or ECM is the cause of the short to ground.

DIAGNOSTIC AIDS:

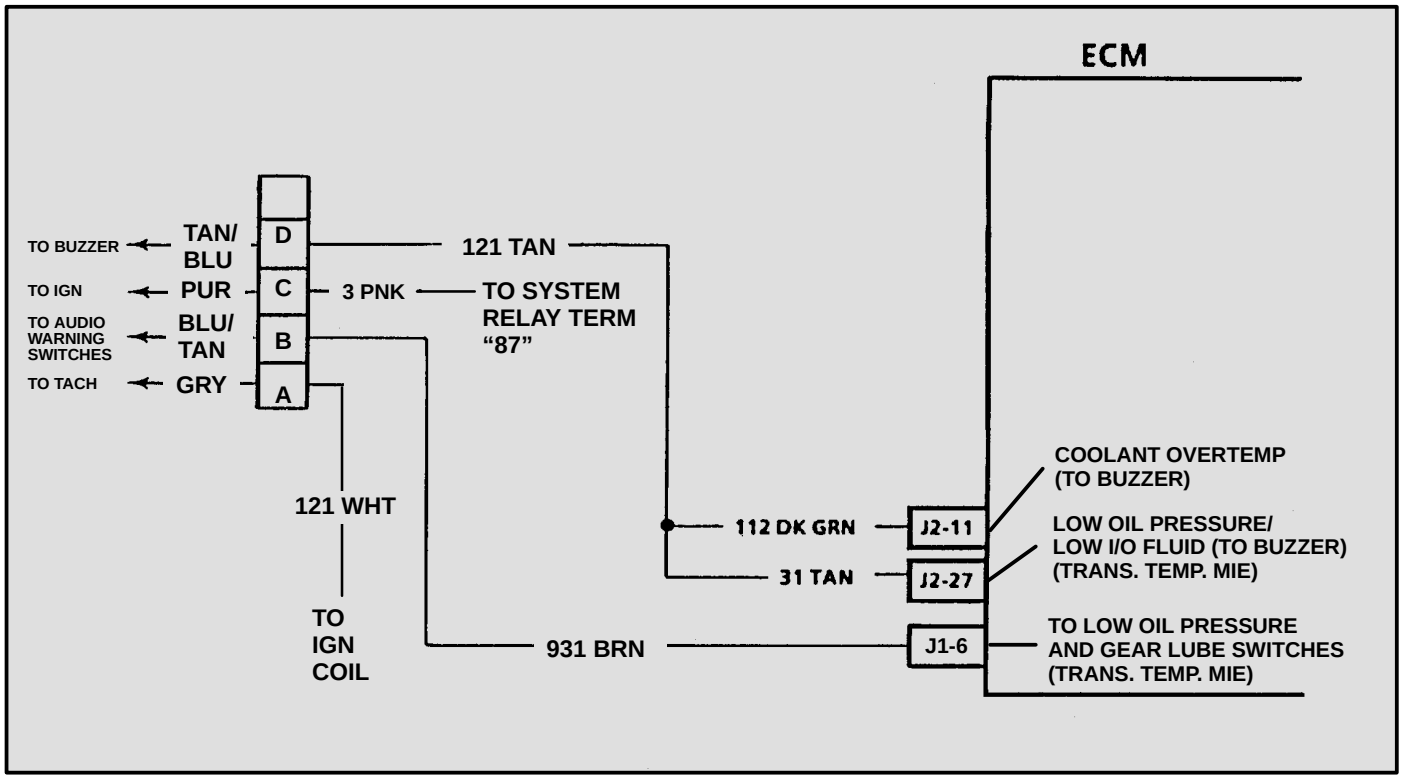
An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness.

Lanyard Stop (Emergency Stop) Circuit Check (2 of 2)


NOTE: THIS CHART ASSUMES THE ENGINE CRANKS BUT WILL NOT START.
1
• TURN IGNITION "OFF."
• TURN IGNITION "ON" AND CRANK ENGINE DOES ENGINE START?
NO
YES
LANYARD STOP CIRCUIT FUNCTIONING PROPERLY. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.
2
• CHECK LANYARD STOP SWITCH TO MAKE SURE SWITCH IS IN ITS NORMAL POSITION. IS IT?
YES
NO
POSITION SWITCH CORRECTLY AND REPEAT STEP #1.
3
• IGNITION "OFF."
• DISCONNECT 2 WAY HARNESS CONNECTOR.
• USING A DVOM, MEASURE RESISTANCE BETWEEN PIN A (CKT 942) AND PIN B (GRD) OF OF 2 WAY CONNECTOR. RESISTANCE SHOULD BE LESS THAN 5K OHMS IS IT?
• RESISTANCE SHOULD BE INFINITE ON LANYARD STOP HARNESS SIDE. IS IT?
NO
YES
BASIC HEI PROBLEM. REFER TO "IGNITION SYSTEM CHECK."
4
RESISTANCE LOWER ON ECM SIDE OF CONNECTOR.
4
RESISTANCE LOWER ON LANYARD STOP SWITCH SIDE OF CONNECTOR.
CHECK FOR FAULTY LANYARD STOP SWITCH. IF OK, REPAIR SHORT TO GROUND IN CKT 942 AND RETEST.
5
• DISCONNECT ECM J-1 CONNECTOR.
• MEASURE RESISTANCE BETWEEN PIN J1-21 OF ECM CONNECTOR AND GROUND. RESISTANCE SHOULD BE INFINITE. IS IT?
YES
NO
FAULTY ECM. REPLACE ECM AND RETEST LANYARD STOP CIRCUIT.
REPAIR SHORT TO GROUND IN CKT 942 BETWEEN ECM J1 CONNECTOR AND LANYARD STOP SWITCH.

Audio Warning Buzzer Circuit Check
(1 of 2)



CIRCUIT DESCRIPTION:

The audio warning buzzer function of the ECM is used to alert the operator of a critical engine function parameter. Used in conjunction with the discrete input circuitry, the ECM will supply ignition current to activate the buzzer if a change of state is indicated by any of the discrete inputs. When a discrete switch changes state from normally open to closed, the ECM interprets that an anomaly is present and will complete the ground to the affected buzzer circuit, energizing the buzzer.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the functional check chart.

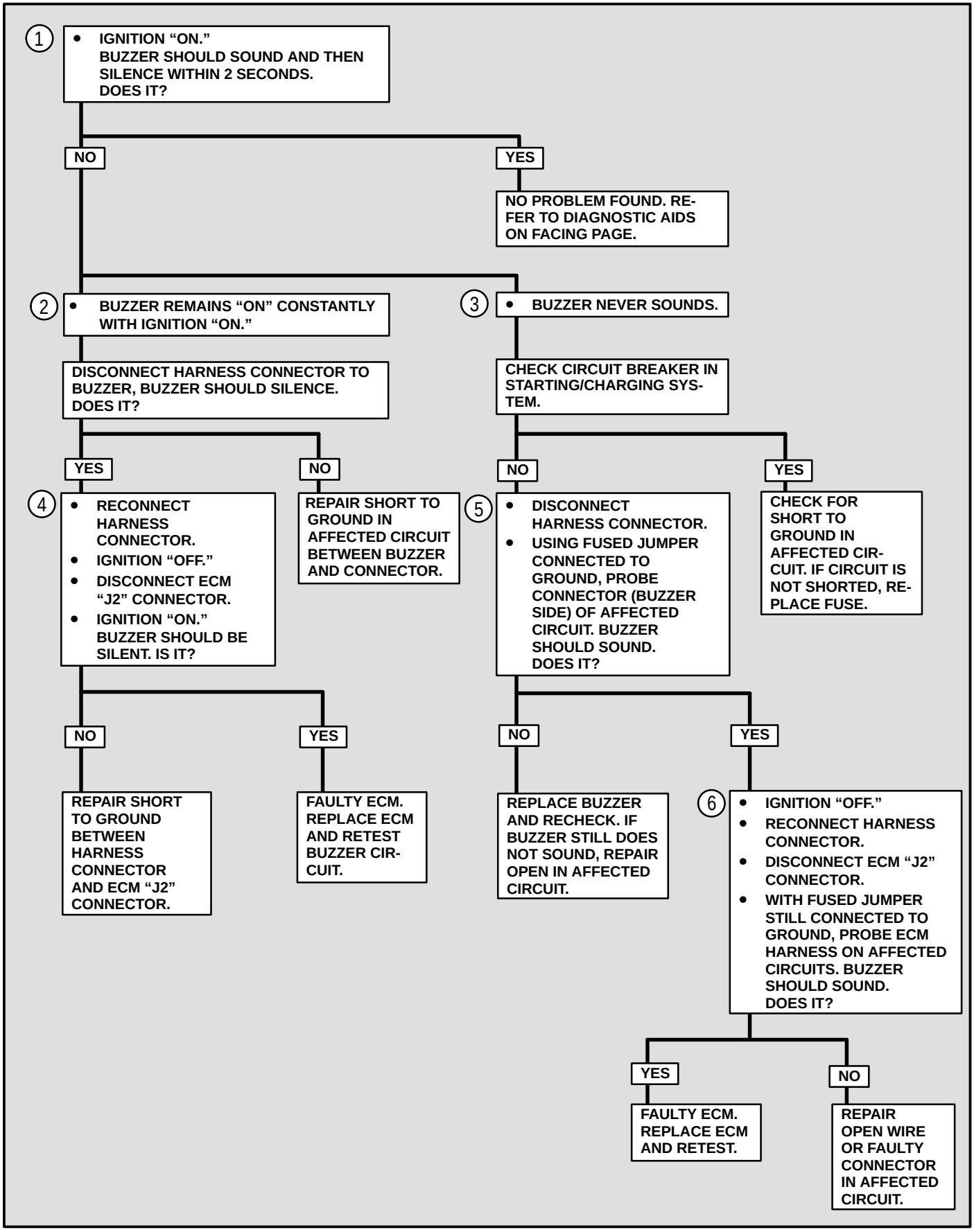
1. This step performs a functional check of the buzzer circuit.
2. This step identifies a short to ground in the control circuit.
3. This step identifies an open in the control circuit.
4. This step identifies if the fault is a short in the harness or a faulty ECM.
5. This step checks for an open in the circuitry from the harness connector to the ignition fuse.
6. This step identifies if the open circuit is due to a faulty ECM or warning buzzer circuitry.

DIAGNOSTIC AIDS:

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness.

Audio Warning Buzzer Circuit Check (2 of 2)


1
IGNITION "ON." BUZZER SHOULD SOUND AND THEN SILENCE WITHIN 2 SECONDS. DOES IT?
NO
YES
NO PROBLEM FOUND. REFER TO DIAGNOSTIC AIDS ON FACING PAGE.
2
BUZZER REMAINS "ON" CONSTANTLY WITH IGNITION "ON."
3
BUZZER NEVER SOUNDS.
DISCONNECT HARNESS CONNECTOR TO BUZZER, BUZZER SHOULD SILENCE. DOES IT?
CHECK CIRCUIT BREAKER IN STARTING/CHARGING SYSTEM.
YES
NO
NO
YES
4
RECONNECT HARNESS CONNECTOR.
IGNITION "OFF."
DISCONNECT ECM "J2" CONNECTOR.
IGNITION "ON." BUZZER SHOULD BE SILENT. IS IT?
REPAIR SHORT TO GROUND IN AFFECTED CIRCUIT BETWEEN BUZZER AND CONNECTOR.
5
DISCONNECT HARNESS CONNECTOR.
USING FUSED JUMPER CONNECTED TO GROUND, PROBE CONNECTOR (BUZZER SIDE) OF AFFECTED CIRCUIT. BUZZER SHOULD SOUND. DOES IT?
CHECK FOR SHORT TO GROUND IN AFFECTED CIRCUIT. IF CIRCUIT IS NOT SHORTED, REPLACE FUSE.
NO
YES
NO
YES
REPAIR SHORT TO GROUND BETWEEN HARNESS CONNECTOR AND ECM "J2" CONNECTOR.
FAULTY ECM. REPLACE ECM AND RETEST BUZZER CIRCUIT.
REPLACE BUZZER AND RECHECK. IF BUZZER STILL DOES NOT SOUND, REPAIR OPEN IN AFFECTED CIRCUIT.
6
IGNITION "OFF."
RECONNECT HARNESS CONNECTOR.
DISCONNECT ECM "J2" CONNECTOR.
WITH FUSED JUMPER STILL CONNECTED TO GROUND, PROBE ECM HARNESS ON AFFECTED CIRCUITS. BUZZER SHOULD SOUND. DOES IT?
YES
NO
FAULTY ECM. REPLACE ECM AND RETEST.
REPAIR OPEN WIRE OR FAULTY CONNECTOR IN AFFECTED CIRCUIT.

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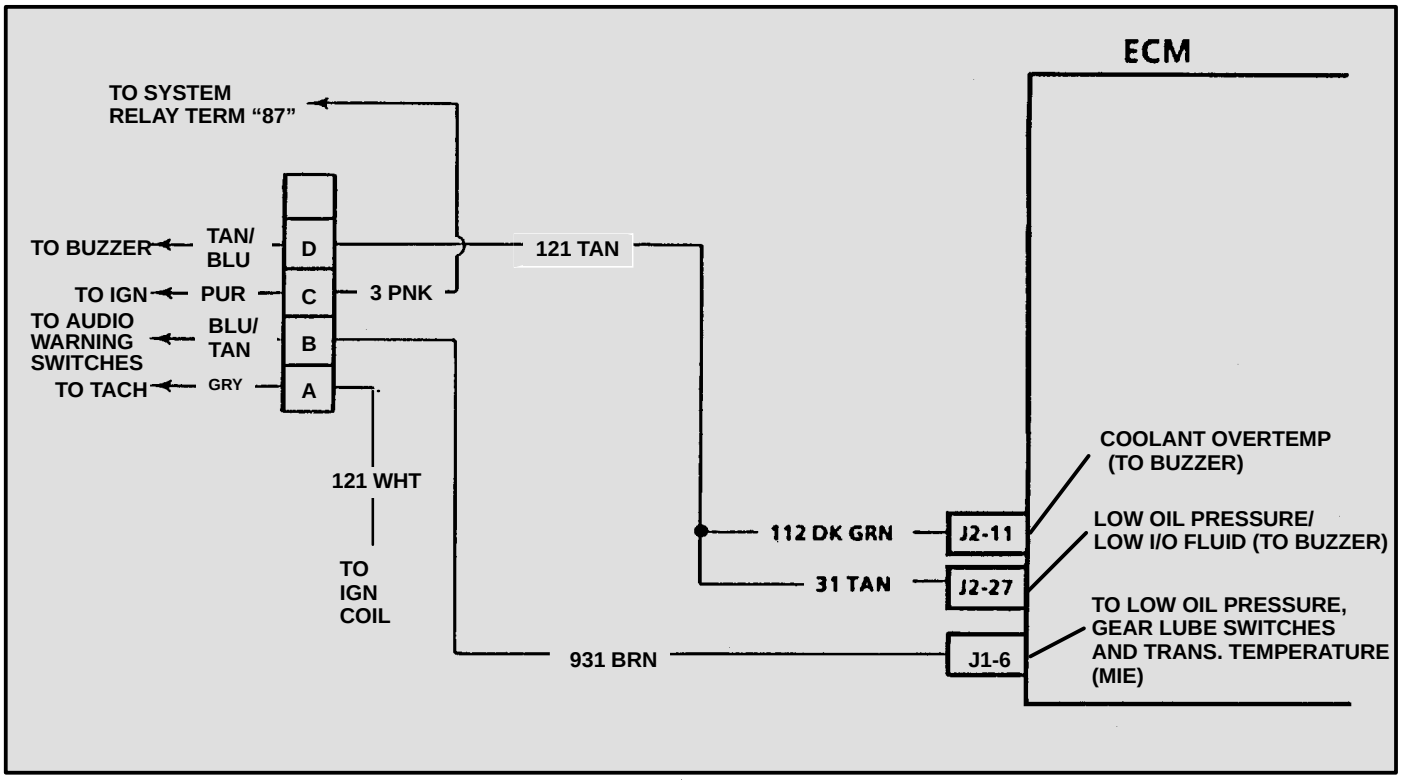
Discrete Input Circuit Check (Power Reduction Mode) (Non-Scan) (1 of 2)



CIRCUIT DESCRIPTION:

Several discrete switch inputs are utilized by the fuel injection system to identify abnormal conditions that may affect engine operation. A pull-up switch is currently used in conjunction with the ECM to detect critical conditions to engine operation.

If a switch changes states from its normal at-rest position, that is normally open to closed, the ECM senses a change in voltage and responds by entering power reduction mode. (And activating the audio warning system.)

NOTE: *Power reduction mode is not used 1997 and later models.*

This engine protection feature allows the driver full engine power up to 2800 RPM, but disables four fuel injectors above 2800 RPM until the engine RPM drops to 1200 RPM.

This feature allows the operator a comfortable maneuvering speed while removing the possibility of high RPM engine operation until the problem is corrected.

TEST DESCRIPTION:

NOTE:Refer to Section 4C to test transmission temperature switch.

1. This step checks if wiring from the engine switches to the ECM is not shorted to ground.
2. This step ensures that the discrete switches are functioning properly by changing state.(I/O oil level, transmission temperature will not change state.)

DIAGNOSTIC AIDS:

- Check engine oil and I/O fluid levels, transmission fluid, overheat.
- If above diagnostics are performed and no change in performance is made, refer to "Troubleshooting."

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, or a wire that is broken inside the insulation.

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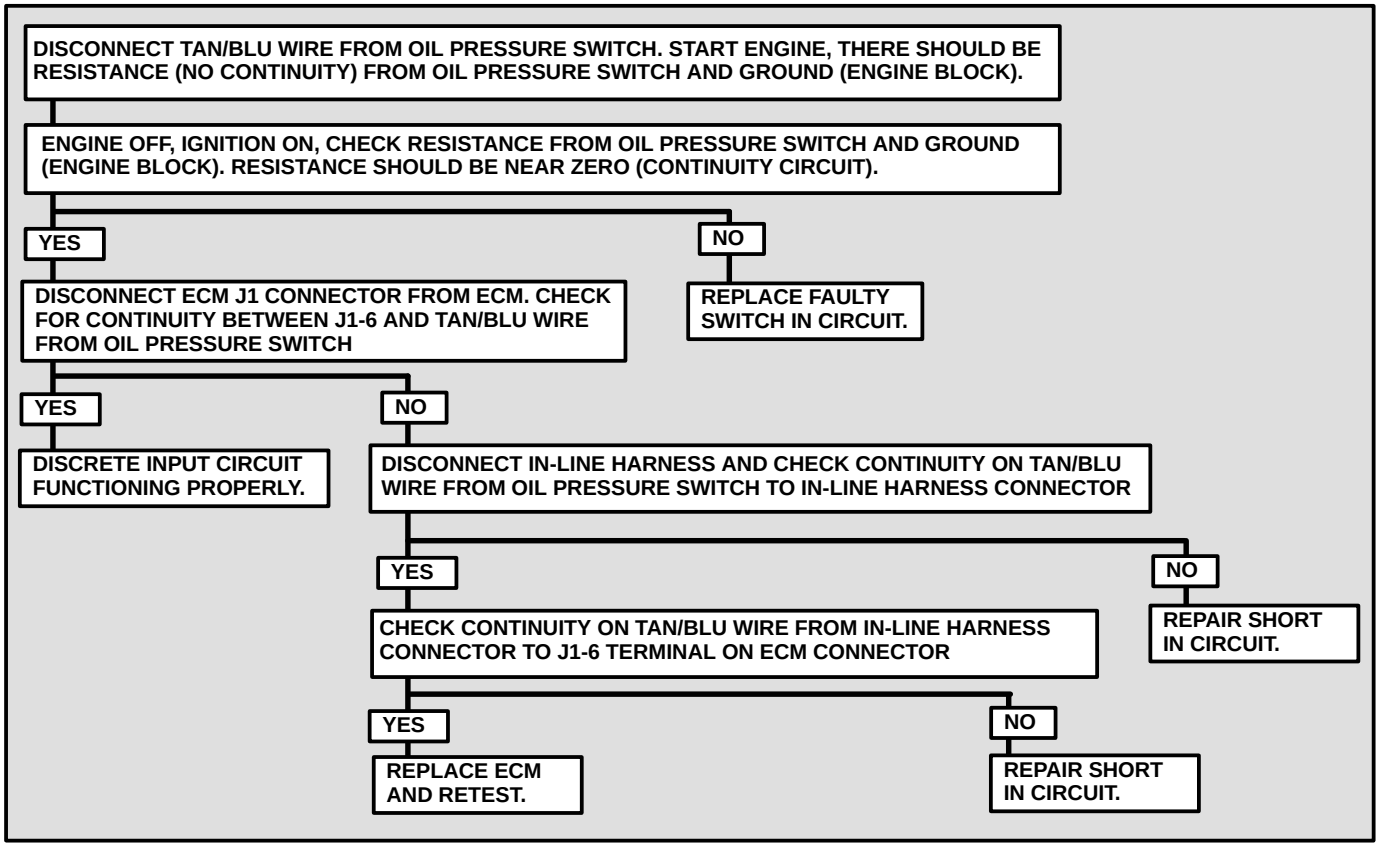
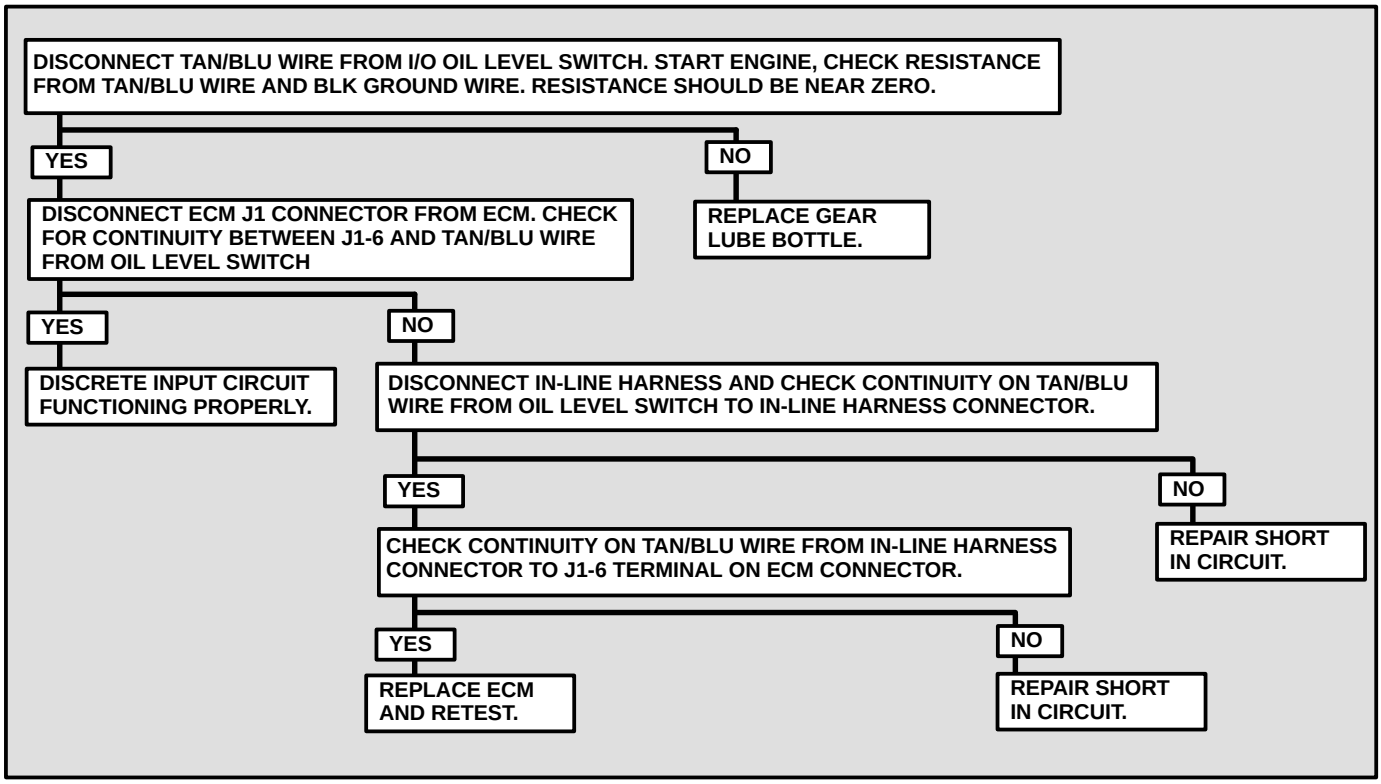
Discrete Input Circuit Check
(2 of 2)

OIL PRESSURE SWITCH


DISCONNECT TAN/BLU WIRE FROM OIL PRESSURE SWITCH. START ENGINE, THERE SHOULD BE RESISTANCE (NO CONTINUITY) FROM OIL PRESSURE SWITCH AND GROUND (ENGINE BLOCK).
ENGINE OFF, IGNITION ON, CHECK RESISTANCE FROM OIL PRESSURE SWITCH AND GROUND (ENGINE BLOCK). RESISTANCE SHOULD BE NEAR ZERO (CONTINUITY CIRCUIT).
YES
NO
REPLACE FAULTY SWITCH IN CIRCUIT.
DISCONNECT ECM J1 CONNECTOR FROM ECM. CHECK FOR CONTINUITY BETWEEN J1-6 AND TAN/BLU WIRE FROM OIL PRESSURE SWITCH
YES
NO
DISCRETE INPUT CIRCUIT FUNCTIONING PROPERLY.
DISCONNECT IN-LINE HARNESS AND CHECK CONTINUITY ON TAN/BLU WIRE FROM OIL PRESSURE SWITCH TO IN-LINE HARNESS CONNECTOR
YES
NO
REPAIR SHORT IN CIRCUIT.
CHECK CONTINUITY ON TAN/BLU WIRE FROM IN-LINE HARNESS CONNECTOR TO J1-6 TERMINAL ON ECM CONNECTOR
YES
NO
REPLACE ECM AND RETEST.
REPAIR SHORT IN CIRCUIT.

I/O LEVEL SWITCH (GEAR LUBE MONITOR)


DISCONNECT TAN/BLU WIRE FROM I/O OIL LEVEL SWITCH. START ENGINE, CHECK RESISTANCE FROM TAN/BLU WIRE AND BLK GROUND WIRE. RESISTANCE SHOULD BE NEAR ZERO.
YES
NO
REPLACE GEAR LUBE BOTTLE.
DISCONNECT ECM J1 CONNECTOR FROM ECM. CHECK FOR CONTINUITY BETWEEN J1-6 AND TAN/BLU WIRE FROM OIL LEVEL SWITCH
YES
NO
DISCRETE INPUT CIRCUIT FUNCTIONING PROPERLY.
DISCONNECT IN-LINE HARNESS AND CHECK CONTINUITY ON TAN/BLU WIRE FROM OIL LEVEL SWITCH TO IN-LINE HARNESS CONNECTOR.
YES
NO
REPAIR SHORT IN CIRCUIT.
CHECK CONTINUITY ON TAN/BLU WIRE FROM IN-LINE HARNESS CONNECTOR TO J1-6 TERMINAL ON ECM CONNECTOR.
YES
NO
REPLACE ECM AND RETEST.
REPAIR SHORT IN CIRCUIT.

REFER TO REPAIR PORTION OF THIS SECTION FOR TESTING OF TRANSMISSION FLUID TEMPERATURE SWITCH.

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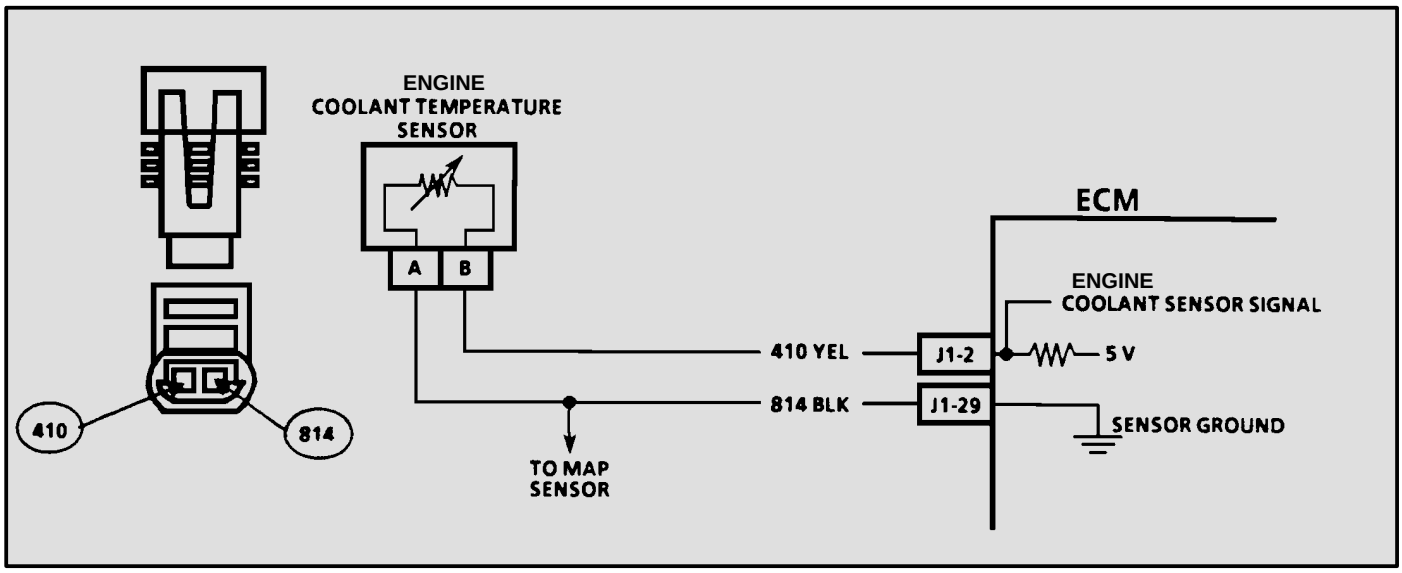
Diagnostics-Without Scan Tool

Code 14: Engine Coolant Temperature (ECT) Sensor Circuit (Non-Scan) (1 of 2)



CIRCUIT DESCRIPTION:

The Engine Coolant Temperature (ECT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 410 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high; therefore, the ECM will see high signal voltage.

As the engine coolant warms, the sensor resistance becomes less, and the voltage drops.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step checks if there is a problem with the ECM and wiring or if the problem is the coolant sensor.
2. Check the harness terminals thoroughly for loose connection. If the resistance or the coolant sensor is monitored, the resistance should steadily decrease as the engine coolant warms up. The resistance reading would stabilize when the thermostat opens.
3. This step will isolate the problem to CKT 410 (5 volt reference) or to the sensor ground.
4. This step identifies if CKT 410 is open or shorted to ground.

DIAGNOSTIC AIDS:

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared. Check harness routing for a potential short to ground in CKT 410. See “Intermittents” in “Troubleshooting.”

IMPORTANT: If replacing the ECT, tighten hand tight plus 2-1/2 turns maximum.

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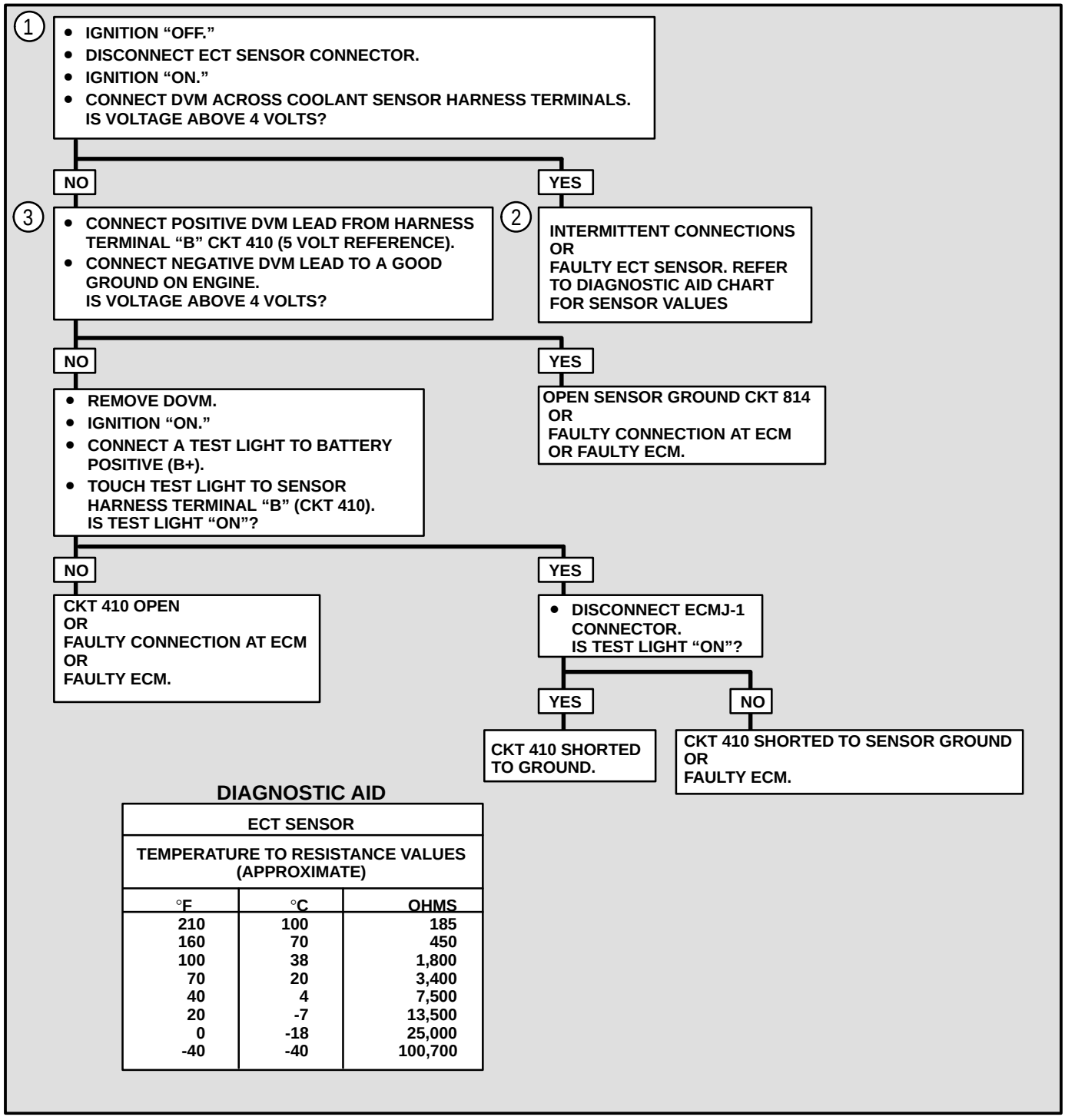
Code 14: ECT Circuit (Non-Scan)
(2 of 2)


1
IGNITION "OFF."
DISCONNECT ECT SENSOR CONNECTOR.
IGNITION "ON."
CONNECT DVM ACROSS COOLANT SENSOR HARNESS TERMINALS.
IS VOLTAGE ABOVE 4 VOLTS?
NO
YES
3
CONNECT POSITIVE DVM LEAD FROM HARNESS TERMINAL "B" CKT 410 (5 VOLT REFERENCE).
CONNECT NEGATIVE DVM LEAD TO A GOOD GROUND ON ENGINE.
IS VOLTAGE ABOVE 4 VOLTS?
2
INTERMITTENT CONNECTIONS OR FAULTY ECT SENSOR. REFER TO DIAGNOSTIC AID CHART FOR SENSOR VALUES
NO
YES
REMOVE DOVM.
IGNITION "ON."
CONNECT A TEST LIGHT TO BATTERY POSITIVE (B+).
TOUCH TEST LIGHT TO SENSOR HARNESS TERMINAL "B" (CKT 410).
IS TEST LIGHT "ON"?
OPEN SENSOR GROUND CKT 814 OR FAULTY CONNECTION AT ECM OR FAULTY ECM.
NO
YES
CKT 410 OPEN OR FAULTY CONNECTION AT ECM OR FAULTY ECM.
DISCONNECT ECMJ-1 CONNECTOR.
IS TEST LIGHT "ON"?
YES
NO
CKT 410 SHORTED TO GROUND.
CKT 410 SHORTED TO SENSOR GROUND OR FAULTY ECM.

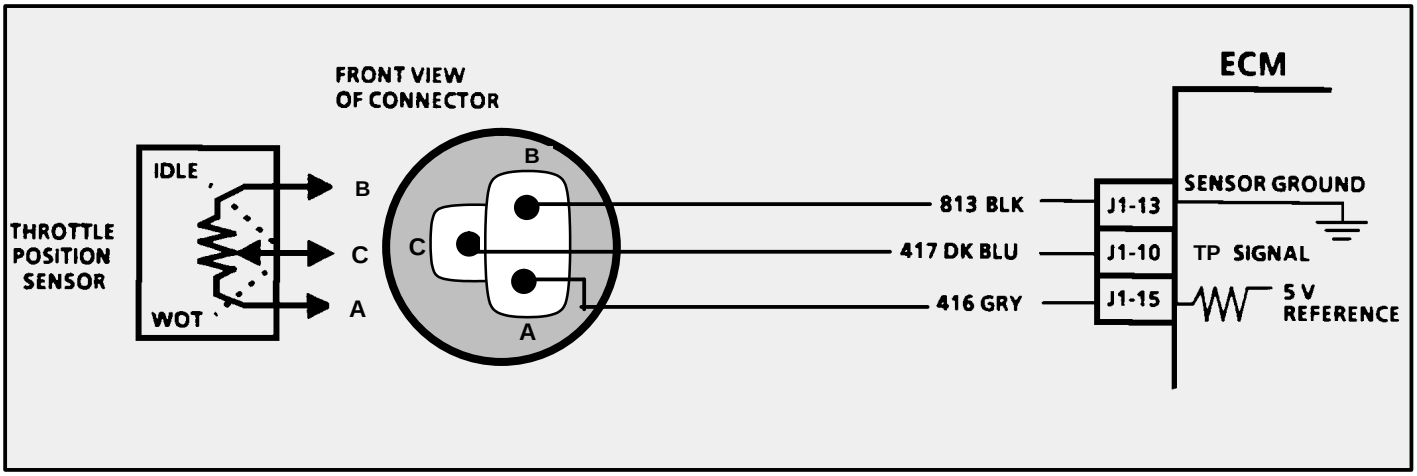
DIAGNOSTIC AID

ECT SENSOR

TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE)

°F	°C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

Code 21: Throttle Position (TP) Sensor Circuit (Non-Scan) (1 Of 2)



CIRCUIT DESCRIPTION:

The Throttle Position (TP) sensor provides a voltage signal that changes, relative to the throttle blade. Signal voltage should vary from about .7 volts at idle to about 4.5 volts at Wide Open Throttle (W.O.T.).

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

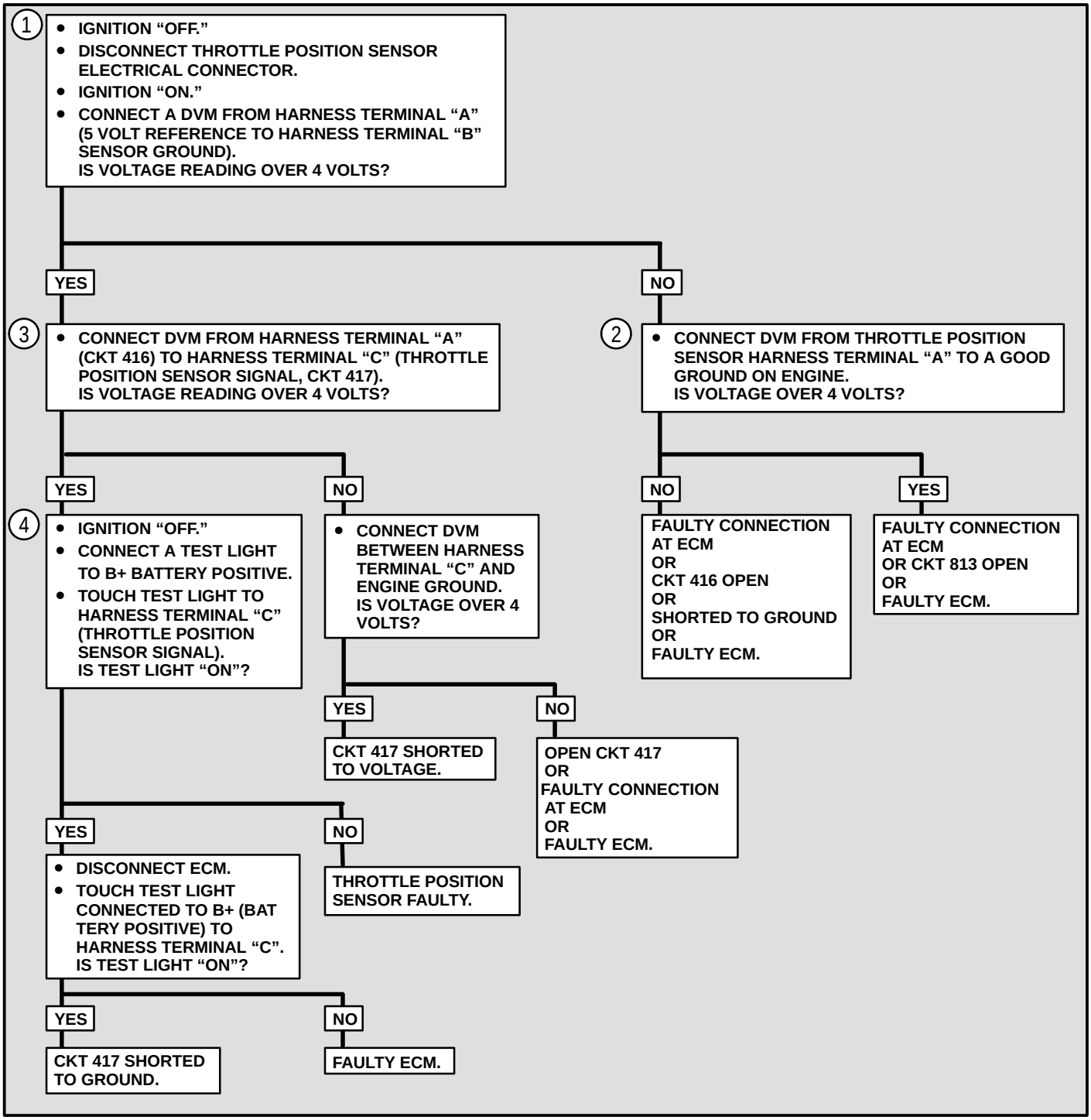
1. This step checks for a voltage from terminal “C” (5 volt reference) to terminal “A” (sensor ground).
2. This step will identify if the problem is in the supply or ground circuit.
3. This step determines if the TP sensor signal circuit to the ECM is open.
4. This step completes the test for the ECM and wiring. If the test light is not ON, the TP sensor has an internal problem.

DIAGNOSTIC AIDS:

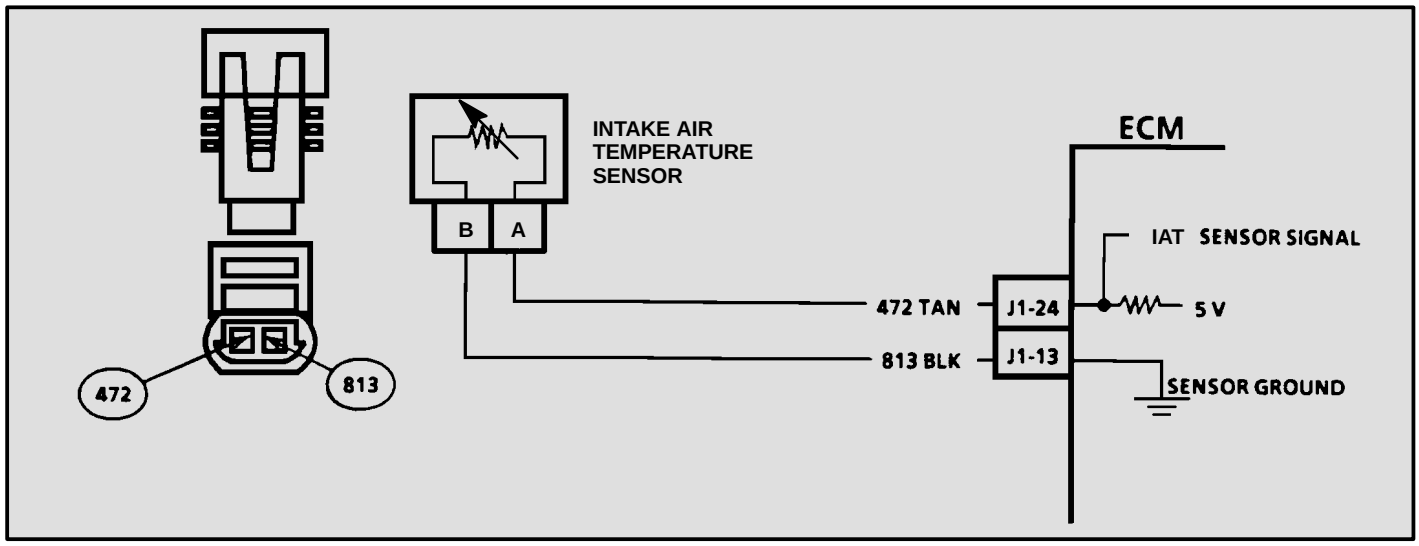
An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared. If Code 23 is also set, check CKT 813 for faulty wiring or connections. Check terminals at sensor for good contact.

Code 21: Throttle Position (TP) Sensor Circuit (Non Scan)



Code 23: Intake Air Temperature (IAT) Sensor Circuit (Non-Scan) (1 Of 2)



CIRCUIT DESCRIPTION:

The Intake Air Temperature (IAT) sensor uses a thermistor to control the signal voltage to the Electronic Control Module (ECM). The ECM applies a voltage (about 5 volts) on CKT 472 to the sensor. When the air is cold, the sensor (thermistor) resistance is high; therefore, the ECM will see a high signal voltage. If the air is warm, the sensor resistance is low; therefore, the ECM will see a low voltage.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. A Code 23 will set due to an open sensor, wire, or connection. This step will determine if the wiring and ECM are OK.
2. If the resistance is greater than 25,000 ohms, replace the sensor.

DIAGNOSTIC AIDS:

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared. If Code 21 is also set, check CKT 813 for faulty wiring or connections. Check terminals at sensor for good contact.

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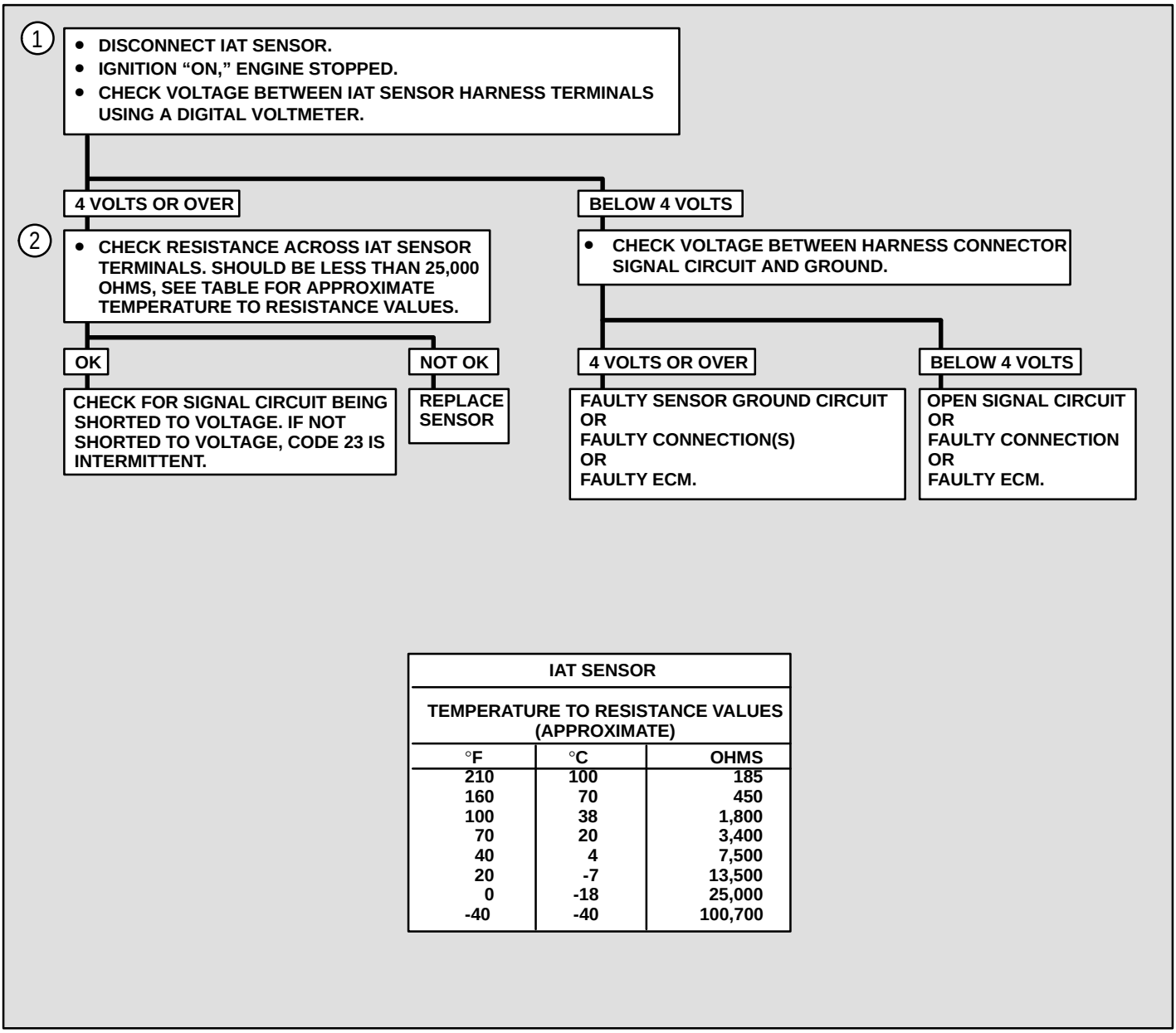
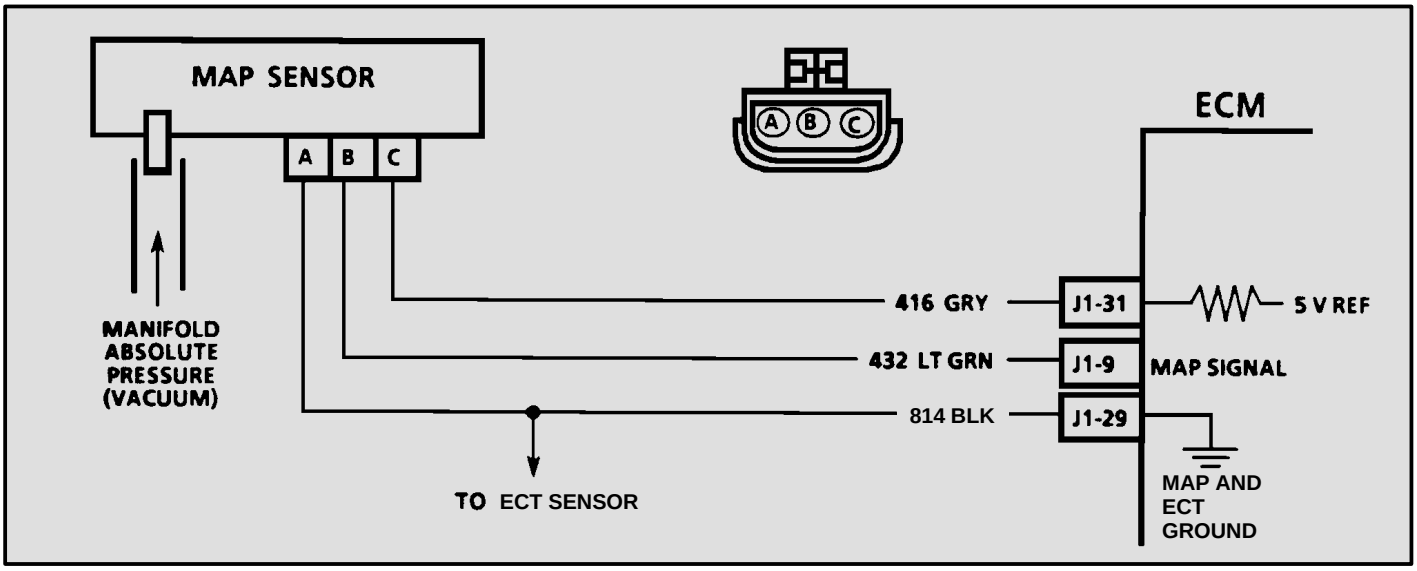
Code 23: Intake Air Temperature (IAT) Sensor Circuit (Non-Scan) (1 of 2)


1
DISCONNECT IAT SENSOR.
IGNITION "ON," ENGINE STOPPED.
CHECK VOLTAGE BETWEEN IAT SENSOR HARNESS TERMINALS USING A DIGITAL VOLTMETER.
4 VOLTS OR OVER
BELOW 4 VOLTS
2
CHECK RESISTANCE ACROSS IAT SENSOR TERMINALS. SHOULD BE LESS THAN 25,000 OHMS, SEE TABLE FOR APPROXIMATE TEMPERATURE TO RESISTANCE VALUES.
CHECK VOLTAGE BETWEEN HARNESS CONNECTOR SIGNAL CIRCUIT AND GROUND.
OK
NOT OK
4 VOLTS OR OVER
BELOW 4 VOLTS
CHECK FOR SIGNAL CIRCUIT BEING SHORTED TO VOLTAGE. IF NOT SHORTED TO VOLTAGE, CODE 23 IS INTERMITTENT.
REPLACE SENSOR
FAULTY SENSOR GROUND CIRCUIT OR FAULTY CONNECTION(S) OR FAULTY ECM.
OPEN SIGNAL CIRCUIT OR FAULTY CONNECTION OR FAULTY ECM.

IAT SENSOR		
TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE)		
°F	°C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

Code 33: Manifold Absolute Pressure (MAP) Sensor Circuit (Non-Scan) (1 Of 2)



CIRCUIT DESCRIPTION:

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1-1.5 volts at closed throttle idle, to 4-4.8 volts at Wide Open Throttle (W.O.T.) (low vacuum).

If the MAP sensor fails, the ECM will substitute a fixed MAP value and use the engine RPM to control fuel delivery.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step will determine if there is an adequate vacuum supply to the MAP sensor. If the gauge reading is erratic, refer to “Stalling, Rough, Unstable or Incorrect Idle” in “Troubleshooting.”
2. Low manifold vacuum may result from vacuum leaks in the engine induction system.
3. This step checks for a voltage from terminal “C” (5 volt reference) to terminal “A” (sensor ground).
4. This step will identify if the problem is in the supply 5 V reference or ground circuit.
5. This step determines if the MAP signal circuit to the ECM is open.
6. This step completes the test for the ECM and wiring. If the test light is not ON, the MAP sensor has an internal problem. To confirm an internal MAP sensor problem, use the MAP output voltage check chart.

DIAGNOSTIC AIDS:

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared. If Code 14 is also set, check for open ground CKT 814.

MAP SENSOR

ALTITUDE		VOLTAGE RANGE
Feet	Meters	
Below 1,000	Below 305	3.8-5.5 V
1,000-2,000	305-610	3.6-5.3 V
2,000-3,000	610-914	3.5-5.1 V
3,000-4,000	914-1219	3.3-5.0 V
4,000-5,000	1219-1524	3.2-4.8 V
5,000-6,000	1524-1829	3.0-4.6 V
6,000-7,000	1829-2133	2.9-4.5 V
7,000-8,000	2133-2438	2.8-4.3 V
8,000-9,000	2438-2743	2.6-4.2 V
9,000-10,000	2743-3048	2.5-4.0 V

LOW ALTITUDE = HIGH PRESSURE = HIGH VOLTAGE

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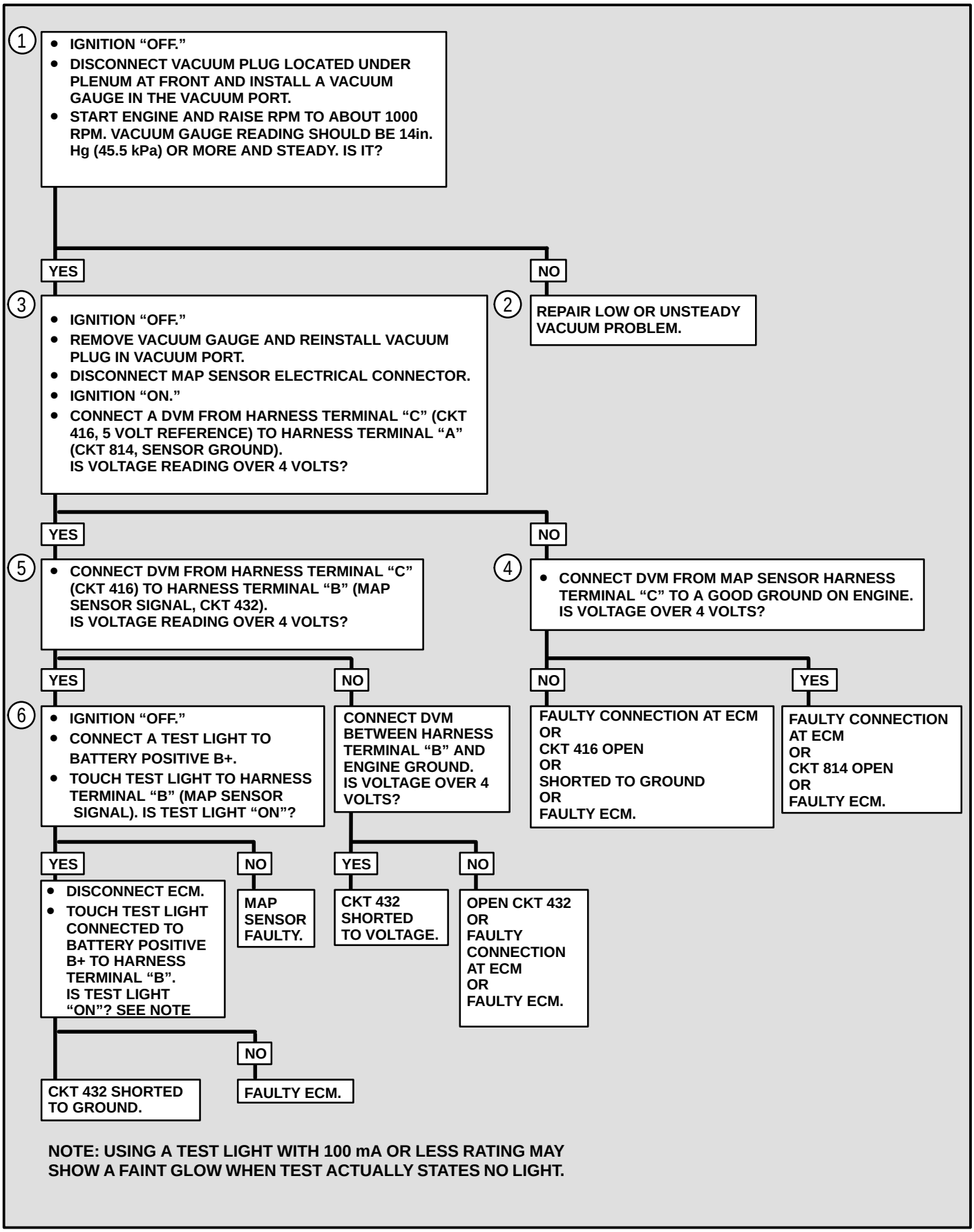
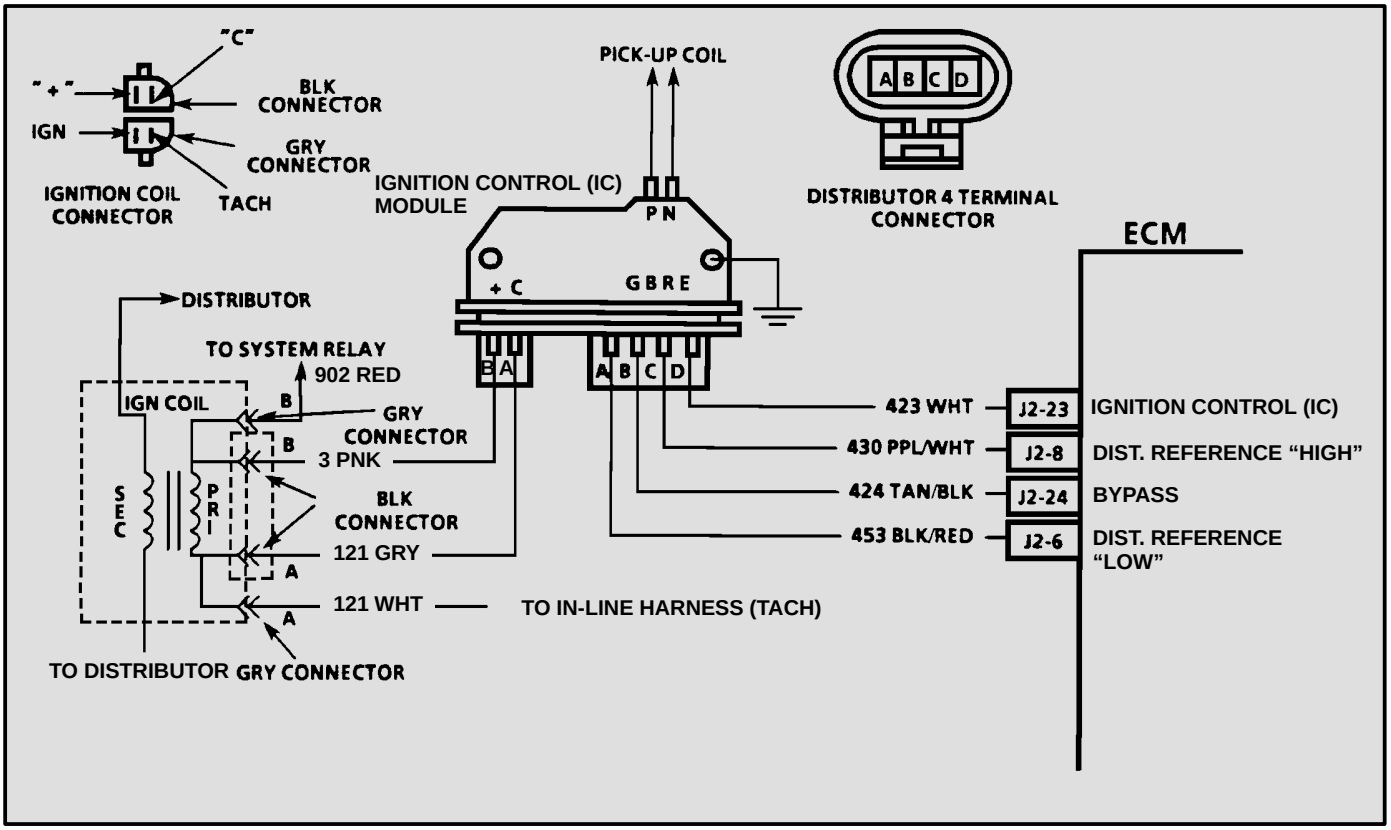
Code 33: MAP Circuit (Non-Scan)
(2 of 2)


1
IGNITION "OFF."
DISCONNECT VACUUM PLUG LOCATED UNDER PLENUM AT FRONT AND INSTALL A VACUUM GAUGE IN THE VACUUM PORT.
START ENGINE AND RAISE RPM TO ABOUT 1000 RPM. VACUUM GAUGE READING SHOULD BE 14in. Hg (45.5 kPa) OR MORE AND STEADY. IS IT?
YES
NO
2
REPAIR LOW OR UNSTEADY VACUUM PROBLEM.
3
IGNITION "OFF."
REMOVE VACUUM GAUGE AND REINSTALL VACUUM PLUG IN VACUUM PORT.
DISCONNECT MAP SENSOR ELECTRICAL CONNECTOR.
IGNITION "ON."
CONNECT A DVM FROM HARNESS TERMINAL "C" (CKT 416, 5 VOLT REFERENCE) TO HARNESS TERMINAL "A" (CKT 814, SENSOR GROUND).
IS VOLTAGE READING OVER 4 VOLTS?
YES
NO
4
CONNECT DVM FROM MAP SENSOR HARNESS TERMINAL "C" TO A GOOD GROUND ON ENGINE.
IS VOLTAGE OVER 4 VOLTS?
NO
FAULTY CONNECTION AT ECM
OR
CKT 416 OPEN
OR
SHORTED TO GROUND
OR
FAULTY ECM.
YES
FAULTY CONNECTION AT ECM
OR
CKT 814 OPEN
OR
FAULTY ECM.
5
CONNECT DVM FROM HARNESS TERMINAL "C" (CKT 416) TO HARNESS TERMINAL "B" (MAP SENSOR SIGNAL, CKT 432).
IS VOLTAGE READING OVER 4 VOLTS?
YES
NO
CONNECT DVM BETWEEN HARNESS TERMINAL "B" AND ENGINE GROUND.
IS VOLTAGE OVER 4 VOLTS?
YES
NO
CKT 432 SHORTED TO VOLTAGE.
OPEN CKT 432
OR
FAULTY CONNECTION AT ECM
OR
FAULTY ECM.
6
IGNITION "OFF."
CONNECT A TEST LIGHT TO BATTERY POSITIVE B+.
TOUCH TEST LIGHT TO HARNESS TERMINAL "B" (MAP SENSOR SIGNAL). IS TEST LIGHT "ON"?
YES
NO
MAP SENSOR FAULTY.
DISCONNECT ECM.
TOUCH TEST LIGHT CONNECTED TO BATTERY POSITIVE B+ TO HARNESS TERMINAL "B".
IS TEST LIGHT "ON"? SEE NOTE
NO
FAULTY ECM.
CKT 432 SHORTED TO GROUND.
NOTE: USING A TEST LIGHT WITH 100 mA OR LESS RATING MAY SHOW A FAINT GLOW WHEN TEST ACTUALLY STATES NO LIGHT.

Code 42: Ignition Control (IC) Circuit (Non-Scan) (1 of 2)



CIRCUIT DESCRIPTION:

When the system is running on the ignition module, that is, no voltage on the bypass line, the ignition module grounds the IC signal. The ECM expects to detect no voltage on the IC line during this condition. If it detects a voltage, it sets Code 42 and will not go into the IC mode.

When the RPM for IC is reached (about 300 RPM), and bypass voltage applied, the IC should no longer be grounded in the ignition module, so the IC voltage should be varying.

If the bypass line is open or grounded, the ignition module will not switch to IC mode so the IC voltage will be low and Code 42 will be set.

If the IC line is grounded, the ignition module will switch to IC but, because the line is grounded, there will be no IC signal. A Code 42 will be set.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

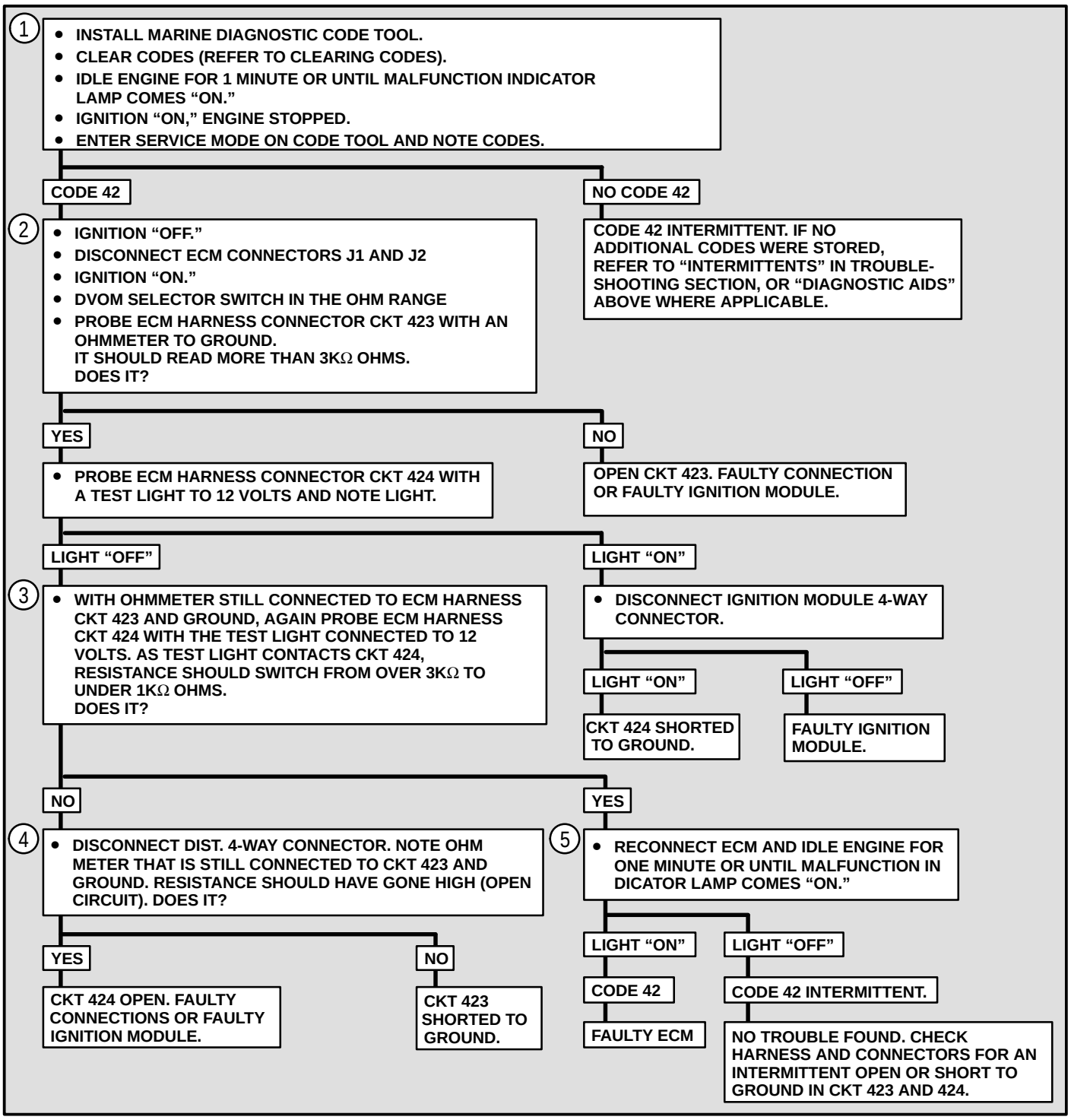
1. Code 42 means the ECM has seen an open or short to ground in the IC or bypass circuits. This test confirms Code 42 and that the fault causing the code is present.
2. Check for a normal IC ground path through the ignition module. An IC CKT 423 shorted to ground will also read more than 3000 ohms; however, this will be checked later.
3. As the test light voltage touches CKT 424, the module should switch, causing the DVM reading to go from over 3000 ohms to under 1000 ohms. The important thing is that the module "switched."
4. The module did not switch and this step checks for:
   - IC CKT 423 shorted to ground.
   - Bypass CKT 424 open.
   - Faulty ignition module connection or module.
5. Confirms that Coded 42 is a faulty ECM and not an intermittent in CKT 423 or CKT 424.

Code 42: IC Circuit (Non-Scan) (2 of 2)

DIAGNOSTIC AIDS:

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.


1
INSTALL MARINE DIAGNOSTIC CODE TOOL.
CLEAR CODES (REFER TO CLEARING CODES).
IDLE ENGINE FOR 1 MINUTE OR UNTIL MALFUNCTION INDICATOR LAMP COMES “ON.”
IGNITION “ON,” ENGINE STOPPED.
ENTER SERVICE MODE ON CODE TOOL AND NOTE CODES.
CODE 42
NO CODE 42
2
IGNITION “OFF.”
DISCONNECT ECM CONNECTORS J1 AND J2
IGNITION “ON.”
DVOM SELECTOR SWITCH IN THE OHM RANGE
PROBE ECM HARNESS CONNECTOR CKT 423 WITH AN OHMMETER TO GROUND.
IT SHOULD READ MORE THAN 3KΩ OHMS.
DOES IT?
CODE 42 INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO “INTERMITTENTS” IN TROUBLE-SHOOTING SECTION, OR “DIAGNOSTIC AIDS” ABOVE WHERE APPLICABLE.
YES
NO
PROBE ECM HARNESS CONNECTOR CKT 424 WITH A TEST LIGHT TO 12 VOLTS AND NOTE LIGHT.
OPEN CKT 423. FAULTY CONNECTION OR FAULTY IGNITION MODULE.
LIGHT “OFF”
LIGHT “ON”
3
WITH OHMMETER STILL CONNECTED TO ECM HARNESS CKT 423 AND GROUND, AGAIN PROBE ECM HARNESS CKT 424 WITH THE TEST LIGHT CONNECTED TO 12 VOLTS. AS TEST LIGHT CONTACTS CKT 424, RESISTANCE SHOULD SWITCH FROM OVER 3KΩ TO UNDER 1KΩ OHMS.
DOES IT?
DISCONNECT IGNITION MODULE 4-WAY CONNECTOR.
LIGHT “ON”
LIGHT “OFF”
CKT 424 SHORTED TO GROUND.
FAULTY IGNITION MODULE.
NO
YES
4
DISCONNECT DIST. 4-WAY CONNECTOR. NOTE OHM METER THAT IS STILL CONNECTED TO CKT 423 AND GROUND. RESISTANCE SHOULD HAVE GONE HIGH (OPEN CIRCUIT). DOES IT?
5
RECONNECT ECM AND IDLE ENGINE FOR ONE MINUTE OR UNTIL MALFUNCTION IN DICATOR LAMP COMES “ON.”
YES
NO
LIGHT “ON”
LIGHT “OFF”
CKT 424 OPEN. FAULTY CONNECTIONS OR FAULTY IGNITION MODULE.
CKT 423 SHORTED TO GROUND.
CODE 42
CODE 42 INTERMITTENT.
FAULTY ECM
NO TROUBLE FOUND. CHECK HARNESS AND CONNECTORS FOR AN INTERMITTENT OPEN OR SHORT TO GROUND IN CKT 423 AND 424.

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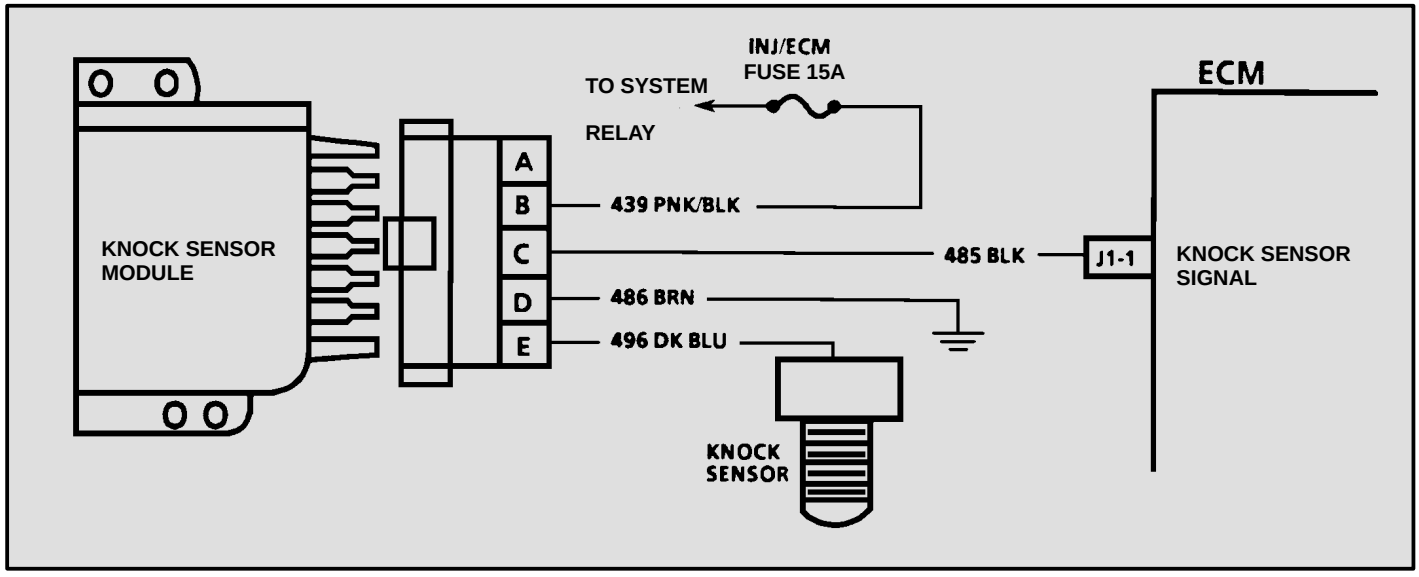
Code 43: Knock Sensor (KS) (Non-Scan)
(1 of 2)



CIRCUIT DESCRIPTION:

The ability to sense engine knock or detonation is accomplished with a module that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage from the KS module to the ECM drops, and this signals the ECM to retard timing.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step ensures that the knock sensor circuitry is within the proper resistance value.
2. Applying 12 volts with a test light to CKT 496 simulates a signal from the knock sensor. The knock sensor is faulty if a response occurs.
3. This step checks if a voltage signal from the KS module is present at the ECM.
4. This step determines if ignition voltage is available to power up the KS module.
5. This step confirms the ability of the KS module to remove the voltage from the signal line when it sees spark knock. Since the knock sensor produces an AC voltage signal, it may be necessary to repeatedly touch the harness connector with the test light probe to simulate this type of signal.
6. This step checks the ground circuit from the KS module. If the test light is dim, check ground (CKT 486) for excessive resistance.

DIAGNOSTIC AIDS:

If CKT 496 is routed too close to secondary ignition wires, the KS module may see the interference as a knock signal, resulting in false retard.

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

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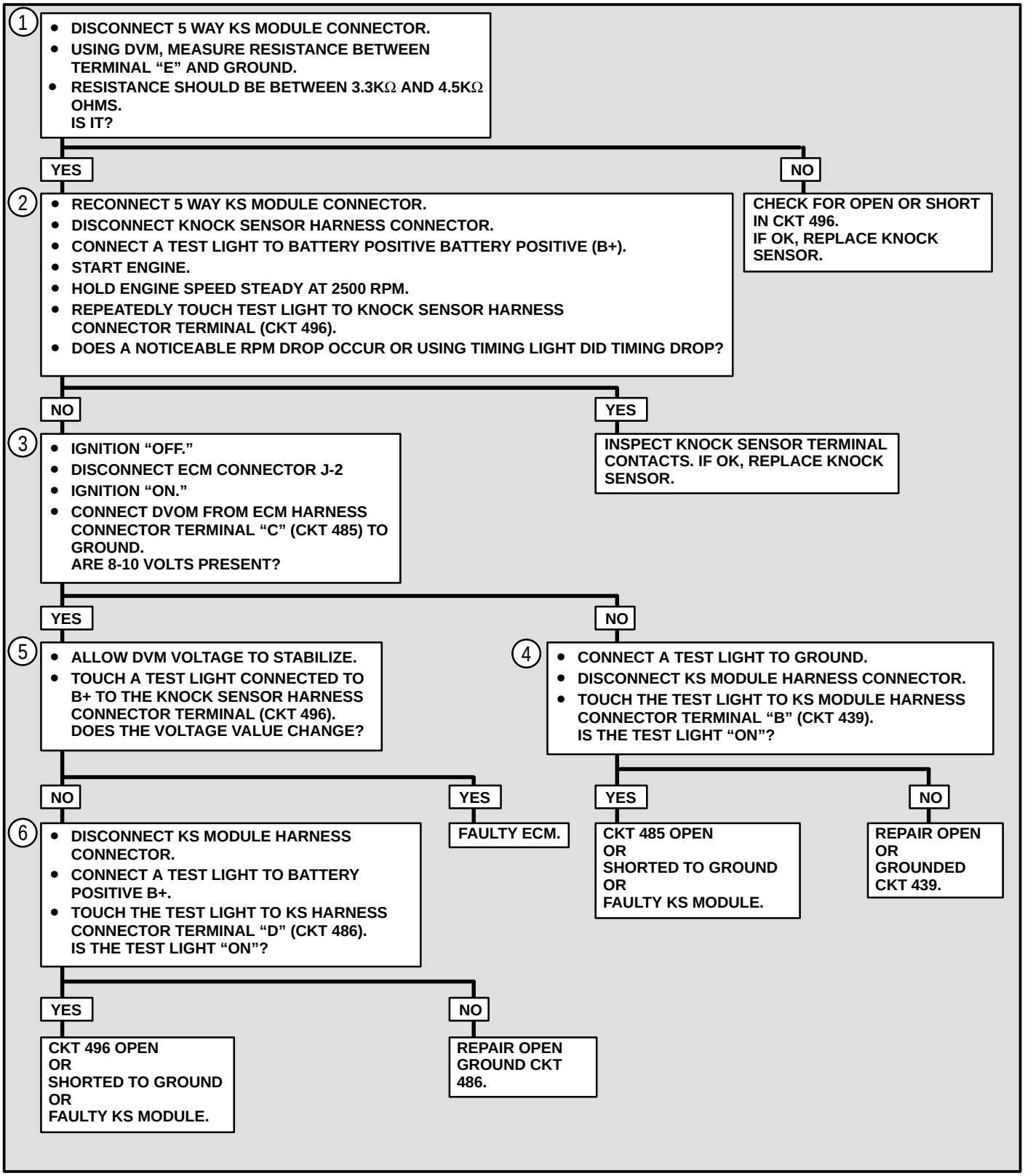
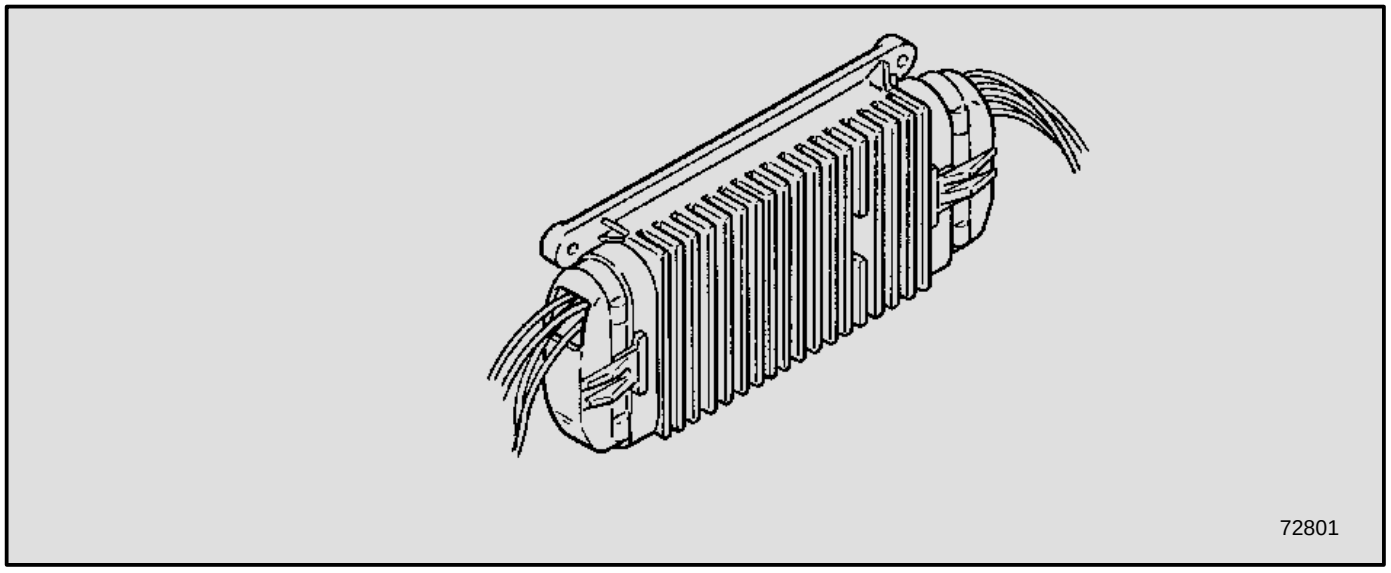
Code 43: Knock Sensor (KS) Circuit (Non-Scan)
(2 of 2)


1
DISCONNECT 5 WAY KS MODULE CONNECTOR.
USING DVM, MEASURE RESISTANCE BETWEEN TERMINAL "E" AND GROUND.
RESISTANCE SHOULD BE BETWEEN 3.3KΩ AND 4.5KΩ OHMS.
IS IT?
YES
NO
CHECK FOR OPEN OR SHORT IN CKT 496.
IF OK, REPLACE KNOCK SENSOR.
2
RECONNECT 5 WAY KS MODULE CONNECTOR.
DISCONNECT KNOCK SENSOR HARNESS CONNECTOR.
CONNECT A TEST LIGHT TO BATTERY POSITIVE BATTERY POSITIVE (B+).
START ENGINE.
HOLD ENGINE SPEED STEADY AT 2500 RPM.
REPEATEDLY TOUCH TEST LIGHT TO KNOCK SENSOR HARNESS CONNECTOR TERMINAL (CKT 496).
DOES A NOTICEABLE RPM DROP OCCUR OR USING TIMING LIGHT DID TIMING DROP?
NO
YES
INSPECT KNOCK SENSOR TERMINAL CONTACTS. IF OK, REPLACE KNOCK SENSOR.
3
IGNITION "OFF."
DISCONNECT ECM CONNECTOR J-2
IGNITION "ON."
CONNECT DVOM FROM ECM HARNESS CONNECTOR TERMINAL "C" (CKT 485) TO GROUND.
ARE 8-10 VOLTS PRESENT?
YES
NO
5
ALLOW DVM VOLTAGE TO STABILIZE.
TOUCH A TEST LIGHT CONNECTED TO B+ TO THE KNOCK SENSOR HARNESS CONNECTOR TERMINAL (CKT 496).
DOES THE VOLTAGE VALUE CHANGE?
4
CONNECT A TEST LIGHT TO GROUND.
DISCONNECT KS MODULE HARNESS CONNECTOR.
TOUCH THE TEST LIGHT TO KS MODULE HARNESS CONNECTOR TERMINAL "B" (CKT 439).
IS THE TEST LIGHT "ON"?
NO
YES
YES
NO
6
DISCONNECT KS MODULE HARNESS CONNECTOR.
CONNECT A TEST LIGHT TO BATTERY POSITIVE B+.
TOUCH THE TEST LIGHT TO KS HARNESS CONNECTOR TERMINAL "D" (CKT 486).
IS THE TEST LIGHT "ON"?
FAULTY ECM.
CKT 485 OPEN OR SHORTED TO GROUND OR FAULTY KS MODULE.
REPAIR OPEN OR GROUNDED CKT 439.
YES
NO
CKT 496 OPEN OR SHORTED TO GROUND OR FAULTY KS MODULE.
REPAIR OPEN GROUND CKT 486.

Code 51: Calibration Memory Failure Non-Scan Diagnostics (1 of 2)



CIRCUIT DESCRIPTION:

This test allows the ECM to check for a calibration failure by comparing the calibration value to a known value stored in the EEPROM.

This test is also used as a security measure to prevent improper use of calibrations or changes to these calibrations that may alter the designed function of the EFI system.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step checks to see if the fault is present during diagnosis. If present, the ECM is not functioning correctly and must be replaced.

IMPORTANT: At the time of printing, vessels with Fuel Injection were not being field reprogrammed to correct this failure. Replacement of the ECM with a factory reprogrammed ECM is necessary if Code 51 is current and resets when clearing codes is completed.

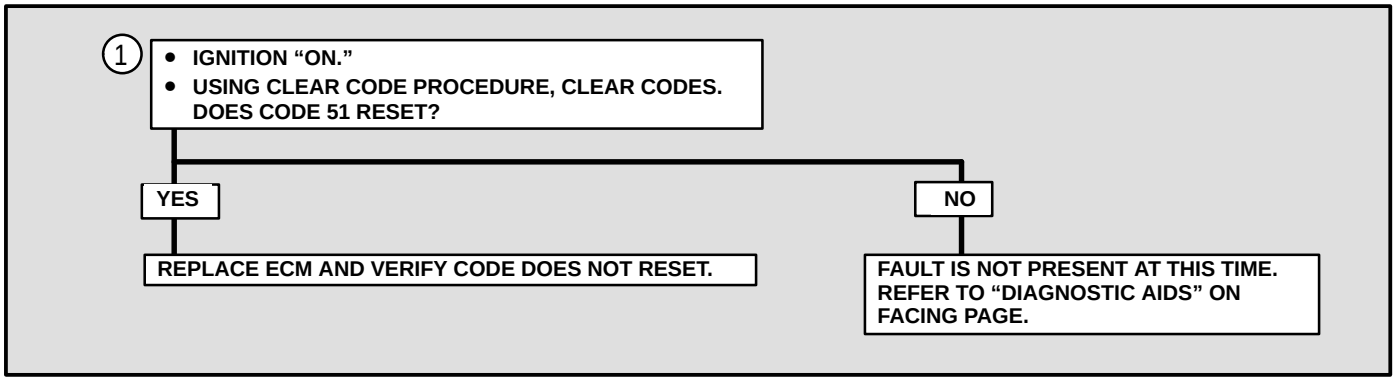
DIAGNOSTIC AIDS:

An intermittent Code 51 may be caused by a bad cell in the EEPROM that is sensitive to temperature changes. If Code 51 failed more than once, but is intermittent, replace ECM.

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

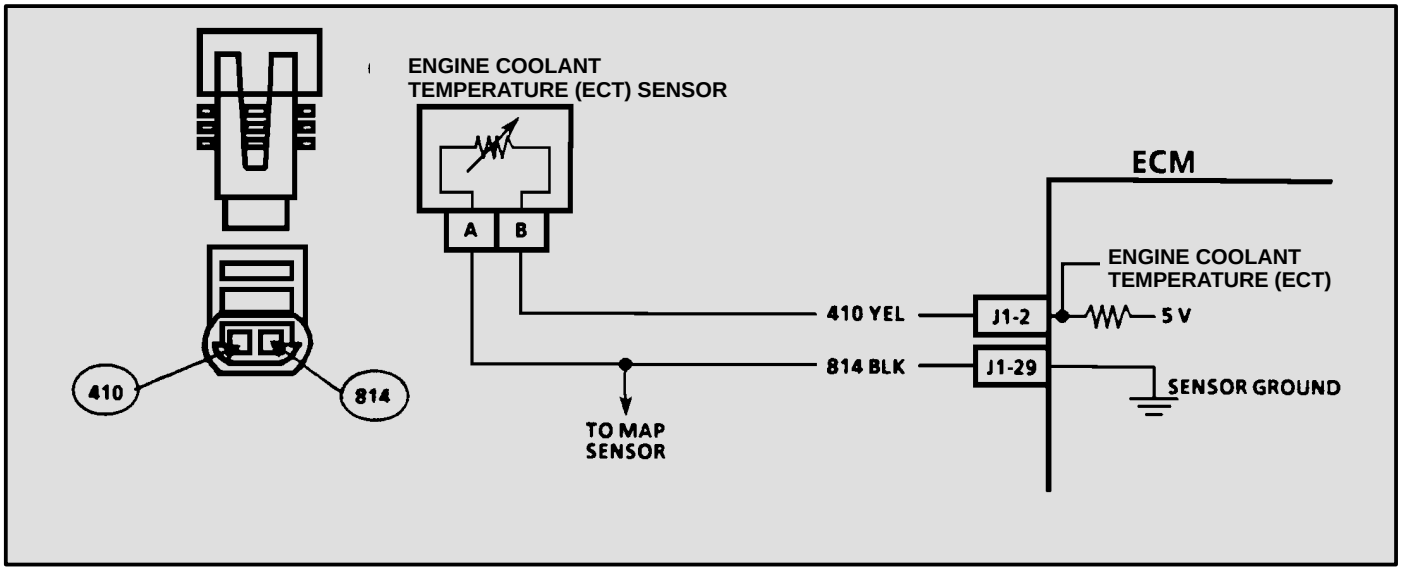
Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

Code 51: Calibration Memory Failure (Non-Scan) (2 of 2)


1
• IGNITION "ON."
• USING CLEAR CODE PROCEDURE, CLEAR CODES. DOES CODE 51 RESET?
YES
NO
REPLACE ECM AND VERIFY CODE DOES NOT RESET.
FAULT IS NOT PRESENT AT THIS TIME. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

Diagnostics - Using Scan Tool (Scan)

Code 14 Engine Coolant Temperature (ECT) Sensor Circuit (Scan) (1 of 2)



CIRCUIT DESCRIPTION:

The Engine Coolant Temperature (ECT) Sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 410 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see high signal voltage. As the engine coolant warms, the sensor resistance becomes less, and the voltage drops. At normal engine operating temperature, 160-180°F (71-82°C), the voltage will measure about 1.5 to 2.0 volts.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Code 14 will set if:
   - Signal voltage indicates a coolant temperature above 266°F (130°C).
   - Signal voltage indicates a coolant temperature below –22°F (–30°C).
2. This test will determine if CKT 410 is shorted to ground, which will cause the condition for Code 14.

DIAGNOSTIC AIDS:

Check harness routing for a potential short to ground in CKT 410.

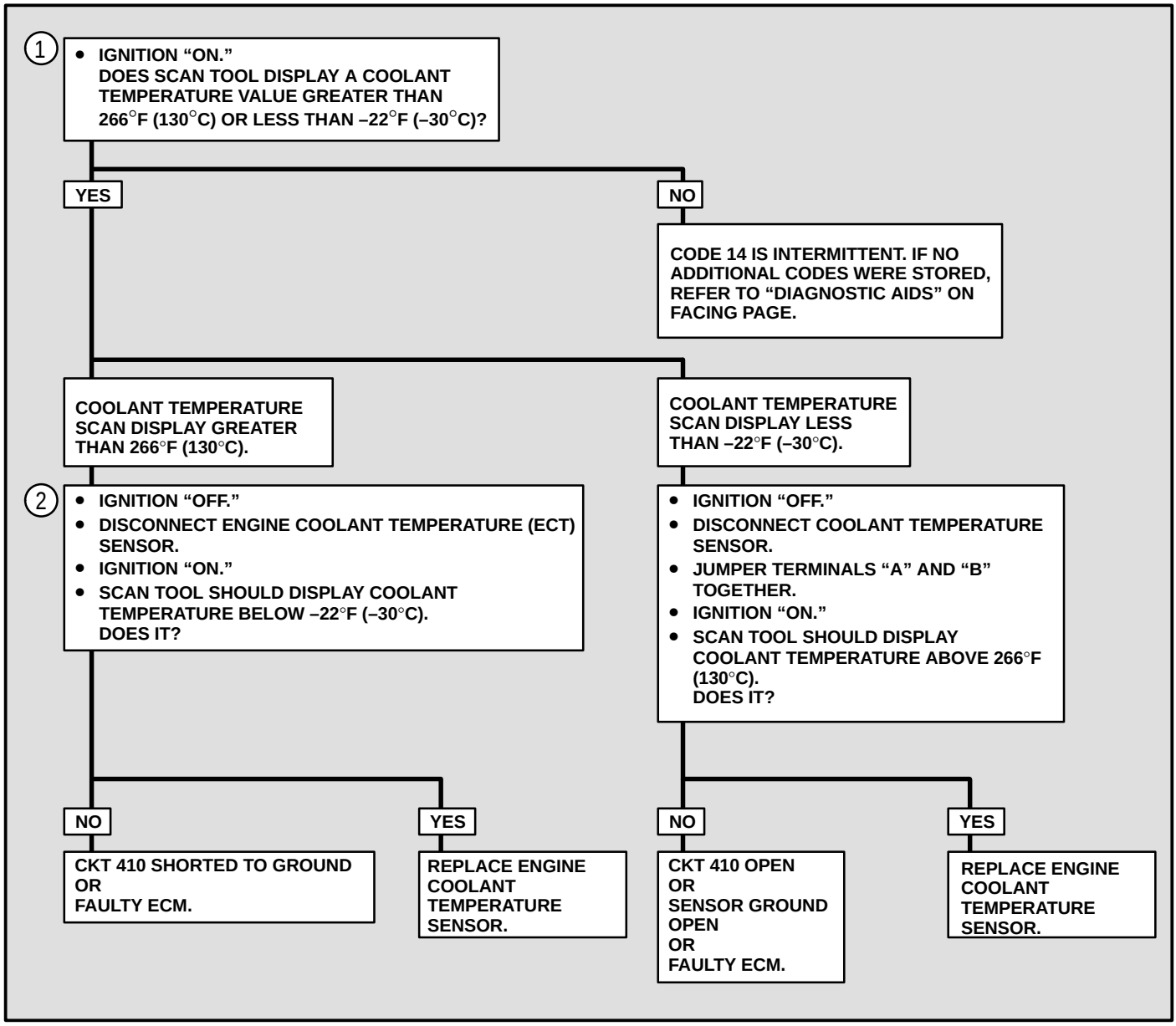
Scan tool displays engine temperature in degrees Fahrenheit and Celsius. After engine is started, the temperature should rise steadily, reach normal operating temperature, and then stabilize when thermostat opens.

See “Intermittents” in “Troubleshooting.”

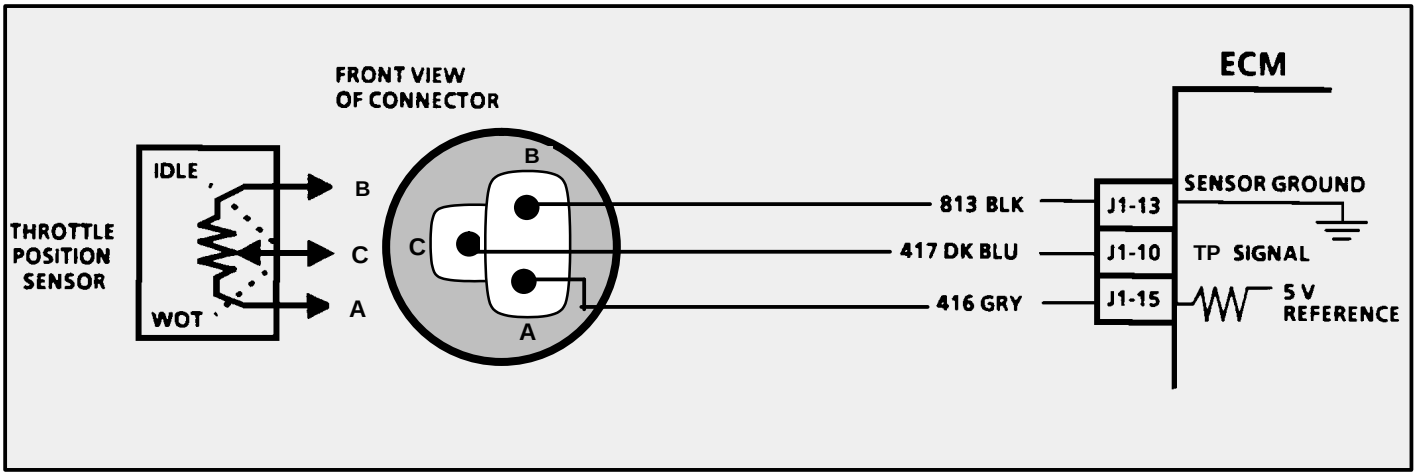
An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

Code 14: ECT Circuit (Scan) (2 of 2)


1
• IGNITION "ON."
DOES SCAN TOOL DISPLAY A COOLANT TEMPERATURE VALUE GREATER THAN 266°F (130°C) OR LESS THAN –22°F (–30°C)?
YES
NO
CODE 14 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.
COOLANT TEMPERATURE SCAN DISPLAY GREATER THAN 266°F (130°C).
COOLANT TEMPERATURE SCAN DISPLAY LESS THAN –22°F (–30°C).
2
• IGNITION "OFF."
• DISCONNECT ENGINE COOLANT TEMPERATURE (ECT) SENSOR.
• IGNITION "ON."
• SCAN TOOL SHOULD DISPLAY COOLANT TEMPERATURE BELOW –22°F (–30°C).
DOES IT?
• IGNITION "OFF."
• DISCONNECT COOLANT TEMPERATURE SENSOR.
• JUMPER TERMINALS "A" AND "B" TOGETHER.
• IGNITION "ON."
• SCAN TOOL SHOULD DISPLAY COOLANT TEMPERATURE ABOVE 266°F (130°C).
DOES IT?
NO
CKT 410 SHORTED TO GROUND OR FAULTY ECM.
YES
REPLACE ENGINE COOLANT TEMPERATURE SENSOR.
NO
CKT 410 OPEN OR SENSOR GROUND OPEN OR FAULTY ECM.
YES
REPLACE ENGINE COOLANT TEMPERATURE SENSOR.

Code 21: Throttle Position (TP) Sensor Circuit (Scan) (1 of 2)



CIRCUIT DESCRIPTION:

The Throttle Position (TP) Sensor provides a voltage signal that changes as throttle blades open or close. Signal voltage should vary from about .7 volts at idle to about 4.5 volts at Wide Open Throttle (W.O.T.).

The TP signal is one of the most important inputs used by the Electronic Control Module (ECM) for fuel control and for most of the ECM controlled outputs.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. With throttle closed the TP sensor should read between .3 and .8 volt. If it does not, check throttle cable adjustment or for bent linkage.
2. With the TP sensor disconnected, the TP voltage should go low if the ECM and wiring are OK.
3. Probing CKT 813 with a DVOM to CKT 416 checks the sensor ground. A faulty sensor ground will cause a Code 21.

DIAGNOSTIC AIDS:

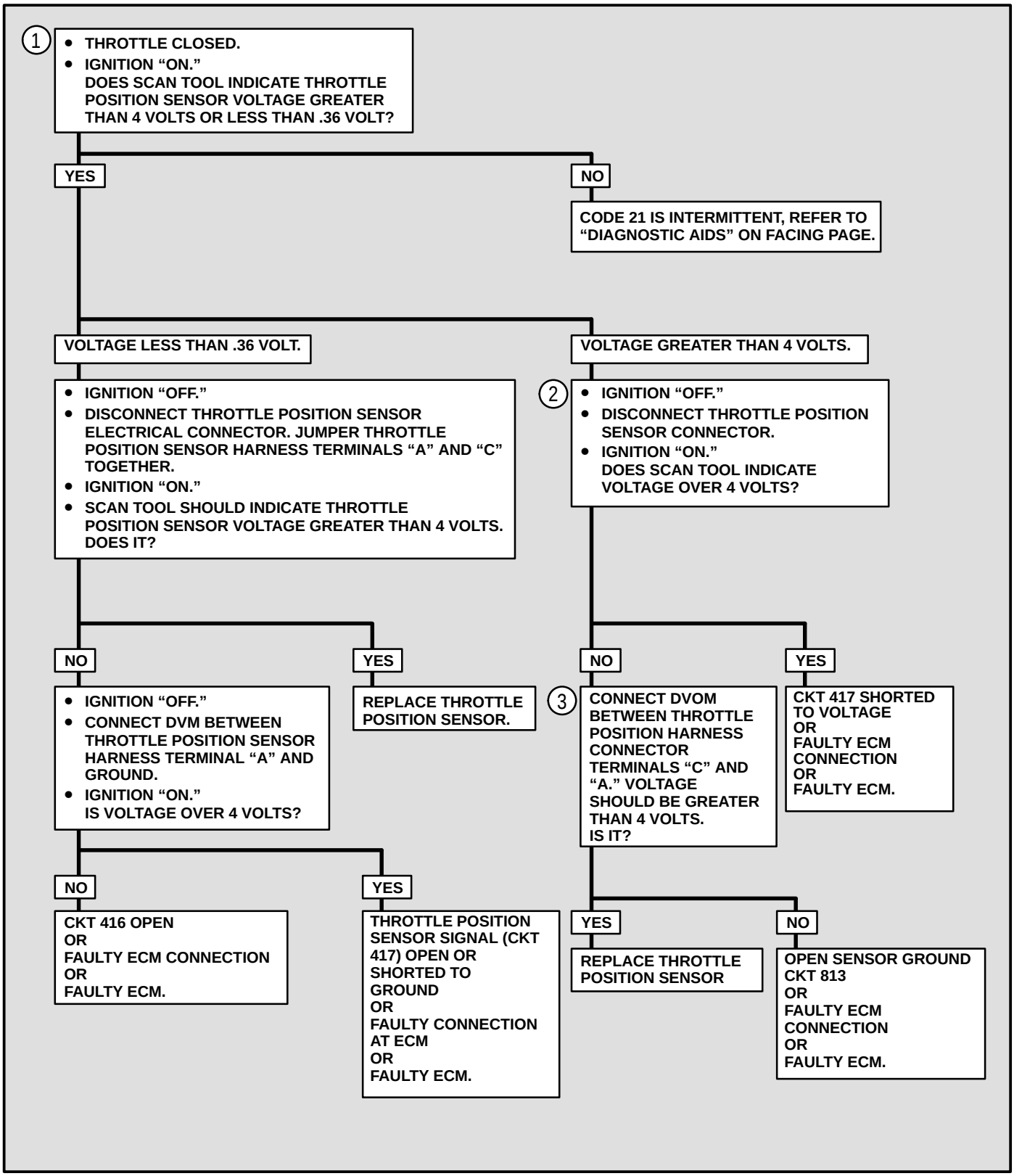
The scan tool reads throttle position in voltage and percentage of throttle blade opening. With ignition ON or at idle, TP signal voltage should read between .3 and .8 volt with the throttle closed, and increase at a steady rate as throttle is moved toward Wide Open Throttle (W.O.T.).

If Code 23 is also set, check CKT 813 for faulty wiring or connections. Check terminals at sensor for good contact.

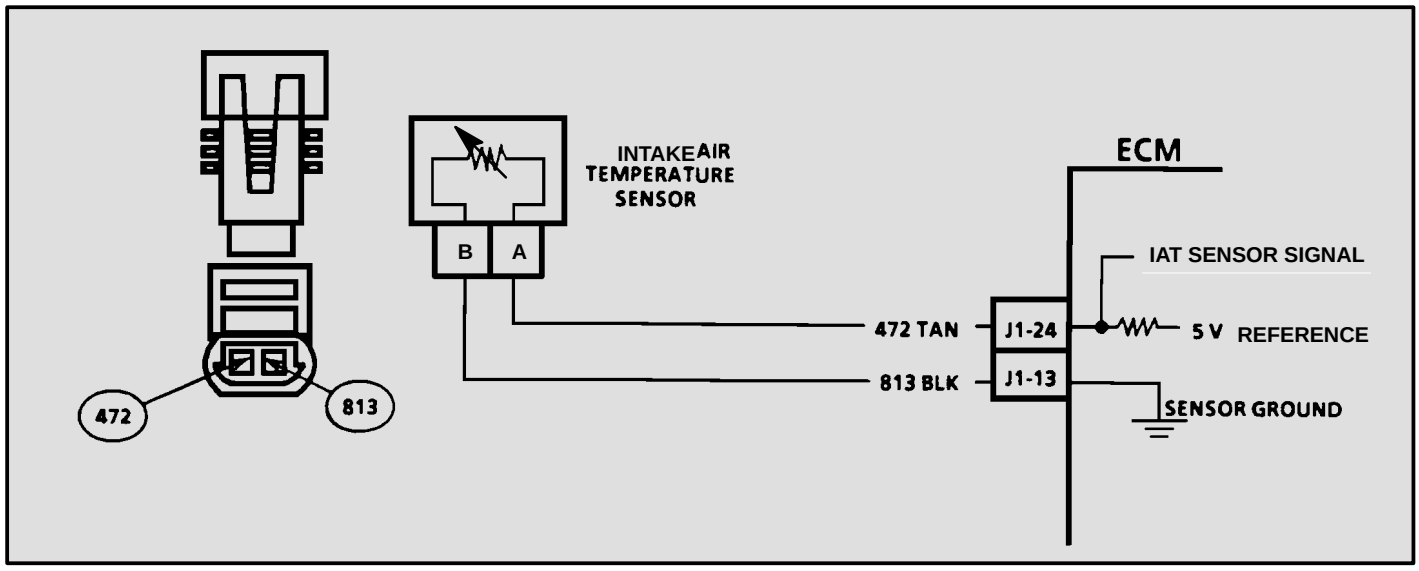
An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

Code 21: TP Sensor Circuit (Scan)
(2 of 2)


1
• THROTTLE CLOSED.
• IGNITION "ON."
DOES SCAN TOOL INDICATE THROTTLE POSITION SENSOR VOLTAGE GREATER THAN 4 VOLTS OR LESS THAN .36 VOLT?
YES
NO
CODE 21 IS INTERMITTENT, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.
VOLTAGE LESS THAN .36 VOLT.
VOLTAGE GREATER THAN 4 VOLTS.
• IGNITION "OFF."
• DISCONNECT THROTTLE POSITION SENSOR ELECTRICAL CONNECTOR. JUMPER THROTTLE POSITION SENSOR HARNESS TERMINALS "A" AND "C" TOGETHER.
• IGNITION "ON."
• SCAN TOOL SHOULD INDICATE THROTTLE POSITION SENSOR VOLTAGE GREATER THAN 4 VOLTS. DOES IT?
2
• IGNITION "OFF."
• DISCONNECT THROTTLE POSITION SENSOR CONNECTOR.
• IGNITION "ON."
DOES SCAN TOOL INDICATE VOLTAGE OVER 4 VOLTS?
NO
YES
NO
YES
• IGNITION "OFF."
• CONNECT DVM BETWEEN THROTTLE POSITION SENSOR HARNESS TERMINAL "A" AND GROUND.
• IGNITION "ON."
IS VOLTAGE OVER 4 VOLTS?
REPLACE THROTTLE POSITION SENSOR.
3
CONNECT DVOM BETWEEN THROTTLE POSITION HARNESS CONNECTOR TERMINALS "C" AND "A." VOLTAGE SHOULD BE GREATER THAN 4 VOLTS.
IS IT?
CKT 417 SHORTED TO VOLTAGE
OR
FAULTY ECM CONNECTION
OR
FAULTY ECM.
NO
YES
YES
NO
CKT 416 OPEN
OR
FAULTY ECM CONNECTION
OR
FAULTY ECM.
THROTTLE POSITION SENSOR SIGNAL (CKT 417) OPEN OR SHORTED TO GROUND
OR
FAULTY CONNECTION AT ECM
OR
FAULTY ECM.
REPLACE THROTTLE POSITION SENSOR
OPEN SENSOR GROUND CKT 813
OR
FAULTY ECM CONNECTION
OR
FAULTY ECM.

Code 23: Intake Air Temperature (IAT) Sensor Circuit (Scan) (1 of 2)



CIRCUIT DESCRIPTION:

The Intake Air Temperature (IAT) sensor uses a thermistor to control the signal voltage to the Electronic Control Module (ECM). The ECM applies a voltage (about 5 volts) on CKT 472 to the sensor. When the air is cold, the sensor (thermistor) resistance is high; therefore, the ECM will see a high signal voltage. If the air is warm, the sensor resistance is low; therefore, the ECM will see a low voltage.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. A Code 23 will set, due to an open sensor, wire or connection. This test will determine if the wiring and ECM are OK. If the scan tool indicates a temperature of over 266°F (130°C), the jumper harness to the sensor should be checked before replacing the sensor.
2. This will determine if the IAT sensor signal (CKT 472) or the IAT sensor ground (CKT 813) is open.
3. This step will determine if the fault is in the IAT sensor or the circuit.

DIAGNOSTIC AIDS:

The scan tool reads temperature of the air entering the engine and should read close to ambient air temperature when engine is cold, and rises as engine compartment temperature increases.

The IAT sensor in this engine is located on the starboard underside of the plenum.

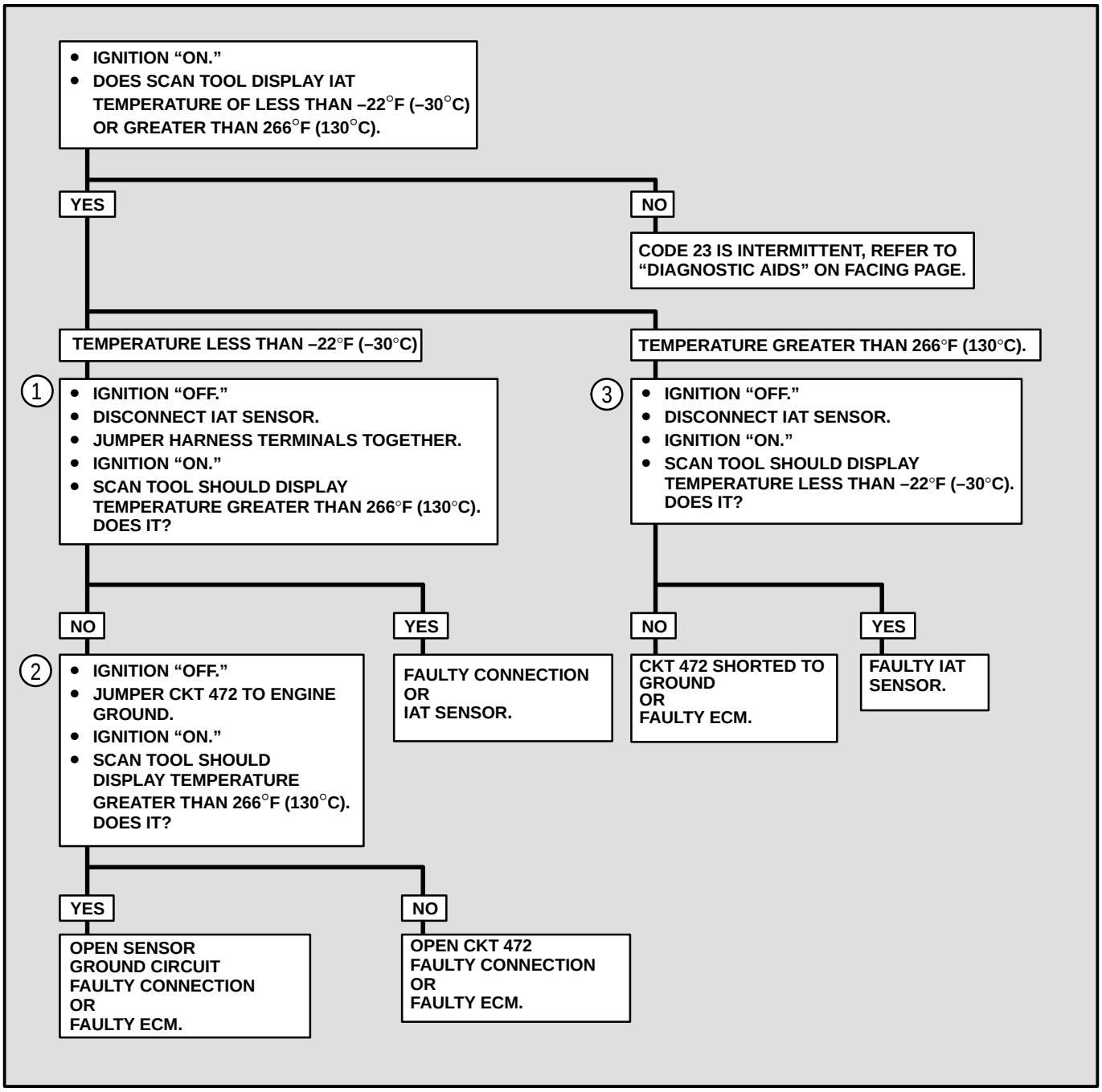
Carefully check harness and connections for possible open.

If the engine has been allowed to sit overnight, the intake air temperature and coolant temperature values should read within a few degrees of each other.

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

Code 23: IAT Circuit (Scan)
(2 of 2)


• IGNITION "ON."
• DOES SCAN TOOL DISPLAY IAT TEMPERATURE OF LESS THAN –22°F (–30°C) OR GREATER THAN 266°F (130°C).
YES
NO
CODE 23 IS INTERMITTENT, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.
TEMPERATURE LESS THAN –22°F (–30°C)
TEMPERATURE GREATER THAN 266°F (130°C).
1
• IGNITION "OFF."
• DISCONNECT IAT SENSOR.
• JUMPER HARNESS TERMINALS TOGETHER.
• IGNITION "ON."
• SCAN TOOL SHOULD DISPLAY TEMPERATURE GREATER THAN 266°F (130°C). DOES IT?
3
• IGNITION "OFF."
• DISCONNECT IAT SENSOR.
• IGNITION "ON."
• SCAN TOOL SHOULD DISPLAY TEMPERATURE LESS THAN –22°F (–30°C). DOES IT?
NO
YES
NO
YES
2
• IGNITION "OFF."
• JUMPER CKT 472 TO ENGINE GROUND.
• IGNITION "ON."
• SCAN TOOL SHOULD DISPLAY TEMPERATURE GREATER THAN 266°F (130°C). DOES IT?
FAULTY CONNECTION OR IAT SENSOR.
CKT 472 SHORTED TO GROUND OR FAULTY ECM.
FAULTY IAT SENSOR.
YES
NO
OPEN SENSOR GROUND CIRCUIT FAULTY CONNECTION OR FAULTY ECM.
OPEN CKT 472 FAULTY CONNECTION OR FAULTY ECM.

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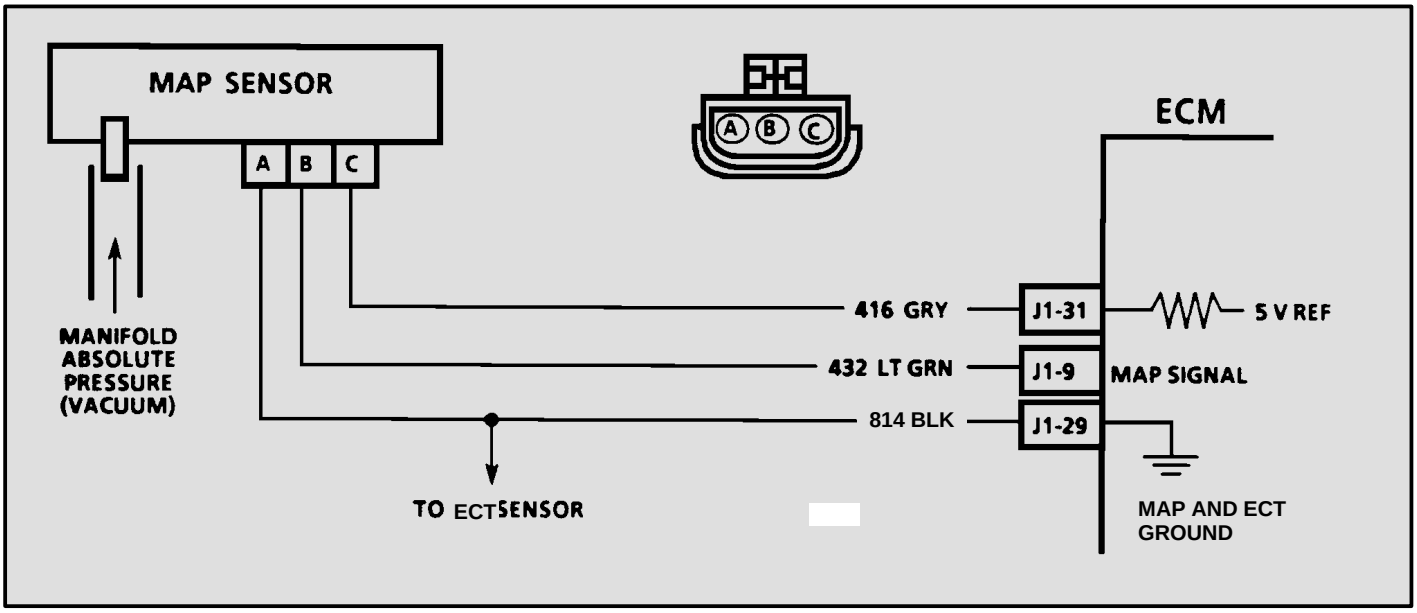
Code 33: Manifold Absolute Pressure (MAP) Sensor Circuit (Scan) (1 of 2)



CIRCUIT DESCRIPTION:

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1-1.5 volts at closed throttle idle, to 4.0-4.8 volts at Wide Open Throttle (W.O.T.) (low vacuum).

The scan tool displays manifold pressure in kPa of pressure and voltage. Low pressure (high vacuum) reads a low voltage while a high pressure (low vacuum) reads a high voltage.

If the MAP sensor fails, the ECM will substitute a fixed MAP value and use engine RPM to control fuel delivery.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Engine misfire or a low unstable idle may set Code 33. Disconnect MAP sensor and system will go into backup mode. If the misfire or idle condition remains, refer to “Troubleshooting.”
2. If the ECM recognizes the low MAP signal, the ECM and wiring are OK.

DIAGNOSTIC AIDS:

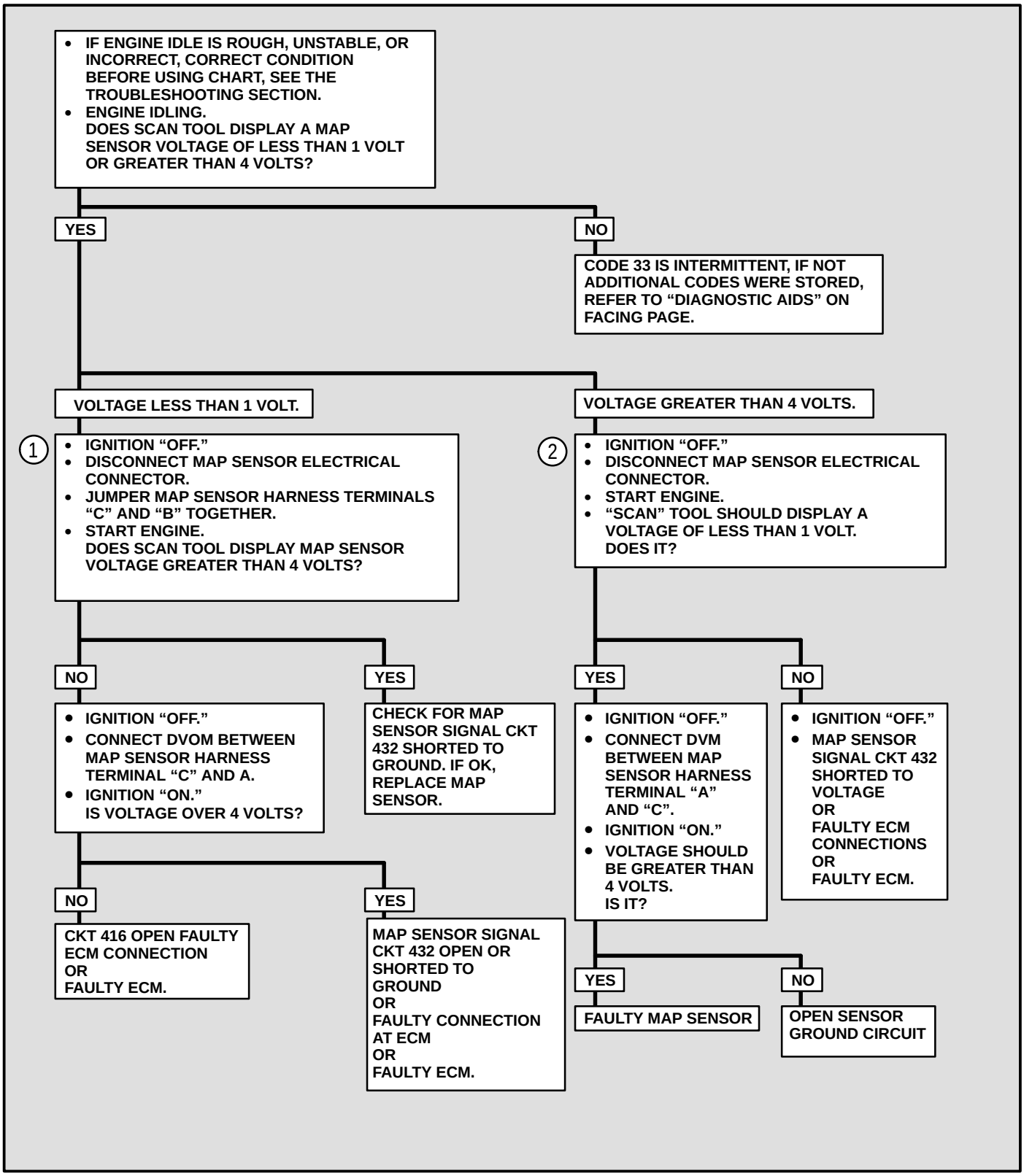
If the idle is rough or unstable, refer to “Troubleshooting” for items which can cause an unstable idle.

With the ignition ON and the engine OFF, the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of vessel altitude and is referred to as BARO. Comparison of this BARO reading, with a known good vessel with the same sensor, is a good way to check accuracy of a “suspect” sensor. Reading should be the same, $\pm$ .4 volt.

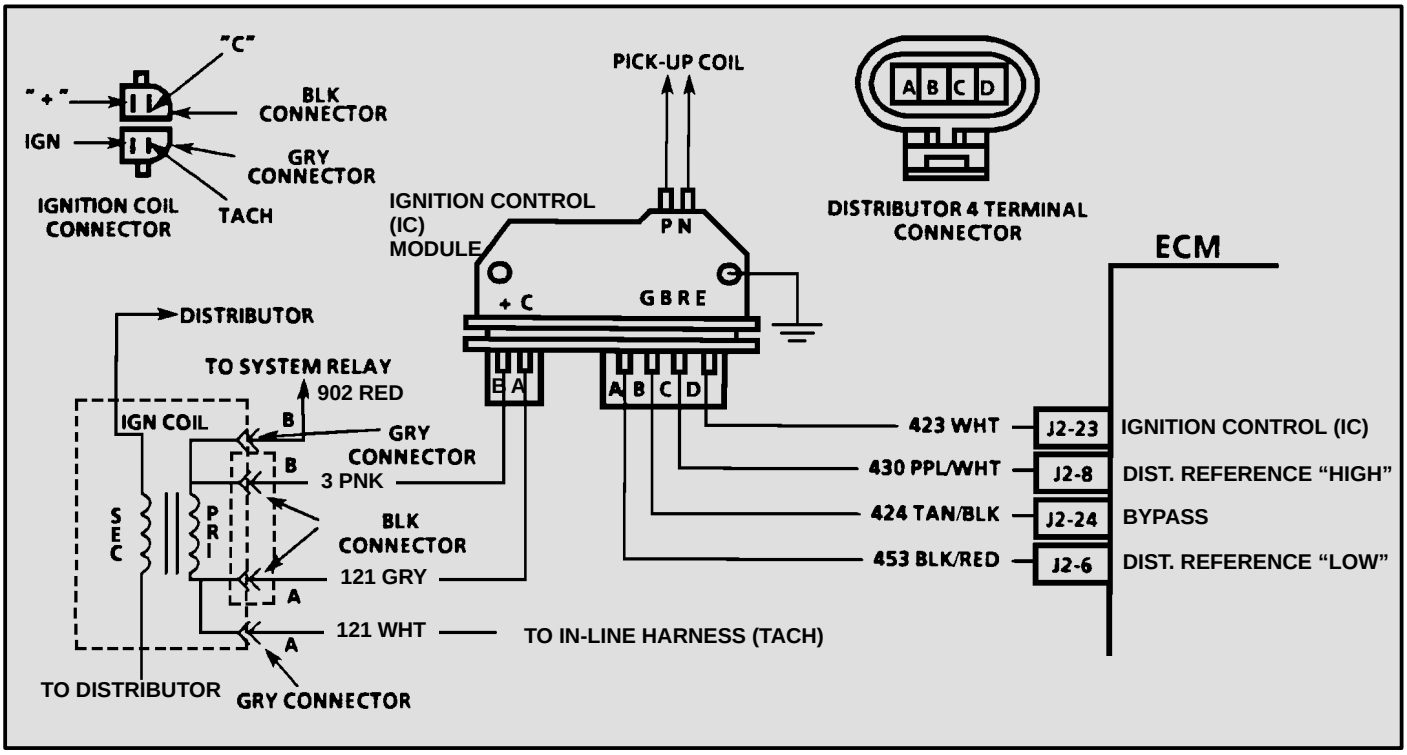
An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

Code 33: MAP Circuit (Scan)
(2 of 2)


• IF ENGINE IDLE IS ROUGH, UNSTABLE, OR INCORRECT, CORRECT CONDITION BEFORE USING CHART, SEE THE TROUBLESHOOTING SECTION.
• ENGINE IDLING. DOES SCAN TOOL DISPLAY A MAP SENSOR VOLTAGE OF LESS THAN 1 VOLT OR GREATER THAN 4 VOLTS?
YES
NO
CODE 33 IS INTERMITTENT, IF NOT ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.
VOLTAGE LESS THAN 1 VOLT.
VOLTAGE GREATER THAN 4 VOLTS.
1
• IGNITION "OFF."
• DISCONNECT MAP SENSOR ELECTRICAL CONNECTOR.
• JUMPER MAP SENSOR HARNESS TERMINALS "C" AND "B" TOGETHER.
• START ENGINE. DOES SCAN TOOL DISPLAY MAP SENSOR VOLTAGE GREATER THAN 4 VOLTS?
2
• IGNITION "OFF."
• DISCONNECT MAP SENSOR ELECTRICAL CONNECTOR.
• START ENGINE.
• "SCAN" TOOL SHOULD DISPLAY A VOLTAGE OF LESS THAN 1 VOLT. DOES IT?
NO
YES
YES
NO
• IGNITION "OFF."
• CONNECT DVOM BETWEEN MAP SENSOR HARNESS TERMINAL "C" AND A.
• IGNITION "ON." IS VOLTAGE OVER 4 VOLTS?
CHECK FOR MAP SENSOR SIGNAL CKT 432 SHORTED TO GROUND. IF OK, REPLACE MAP SENSOR.
• IGNITION "OFF."
• CONNECT DVM BETWEEN MAP SENSOR HARNESS TERMINAL "A" AND "C".
• IGNITION "ON."
• VOLTAGE SHOULD BE GREATER THAN 4 VOLTS. IS IT?
• IGNITION "OFF."
• MAP SENSOR SIGNAL CKT 432 SHORTED TO VOLTAGE OR FAULTY ECM CONNECTIONS OR FAULTY ECM.
NO
YES
YES
NO
CKT 416 OPEN FAULTY ECM CONNECTION OR FAULTY ECM.
MAP SENSOR SIGNAL CKT 432 OPEN OR SHORTED TO GROUND OR FAULTY CONNECTION AT ECM OR FAULTY ECM.
FAULTY MAP SENSOR
OPEN SENSOR GROUND CIRCUIT

Code 42: Ignition Control (IC) Circuit (Scan) (1 Of 2)



CIRCUIT DESCRIPTION:

When the system is running on the ignition module, that is, no voltage on the bypass line, the ignition module grounds the IC signal. The ECM expects to detect a low voltage on the IC line during this condition. If it detects a voltage, it sets Code 42 and will not go into the IC mode.

When the RPM for IC is reached (about 300 RPM), and bypass voltage applied, the IC should no longer be grounded in the ignition module, so the IC voltage should be varying.

If the bypass line is open or grounded, the ignition module will not switch to IC mode so the IC voltage will be low and Code 42 will be set.

If the IC line is grounded, the ignition module will switch to IC but, because the line is grounded, there will be no IC signal. A Code 42 will be set.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Code 42 means the ECM has seen an open or short to ground in the IC or bypass circuits. This test confirms Code 42 and that the fault causing the code is present.
2. Check for a normal IC ground path through the ignition module. An IC CKT 423 shorted to ground will also read more than 3000 ohms; however, this will be checked later.
3. As the test light voltage touches CKT 424, the module should switch, causing the DVOM reading to go from over 3000 ohms to under 1000 ohms. The important thing is that the module "switched."
4. The module did not switch and this step checks for:
   - IC CKT 423 shorted to ground.
   - Bypass CKT 424 open.
   - Faulty ignition module connection or module.
5. Confirms that Coded 42 is a faulty ECM and not an intermittent in CKT 423 or CKT 424.

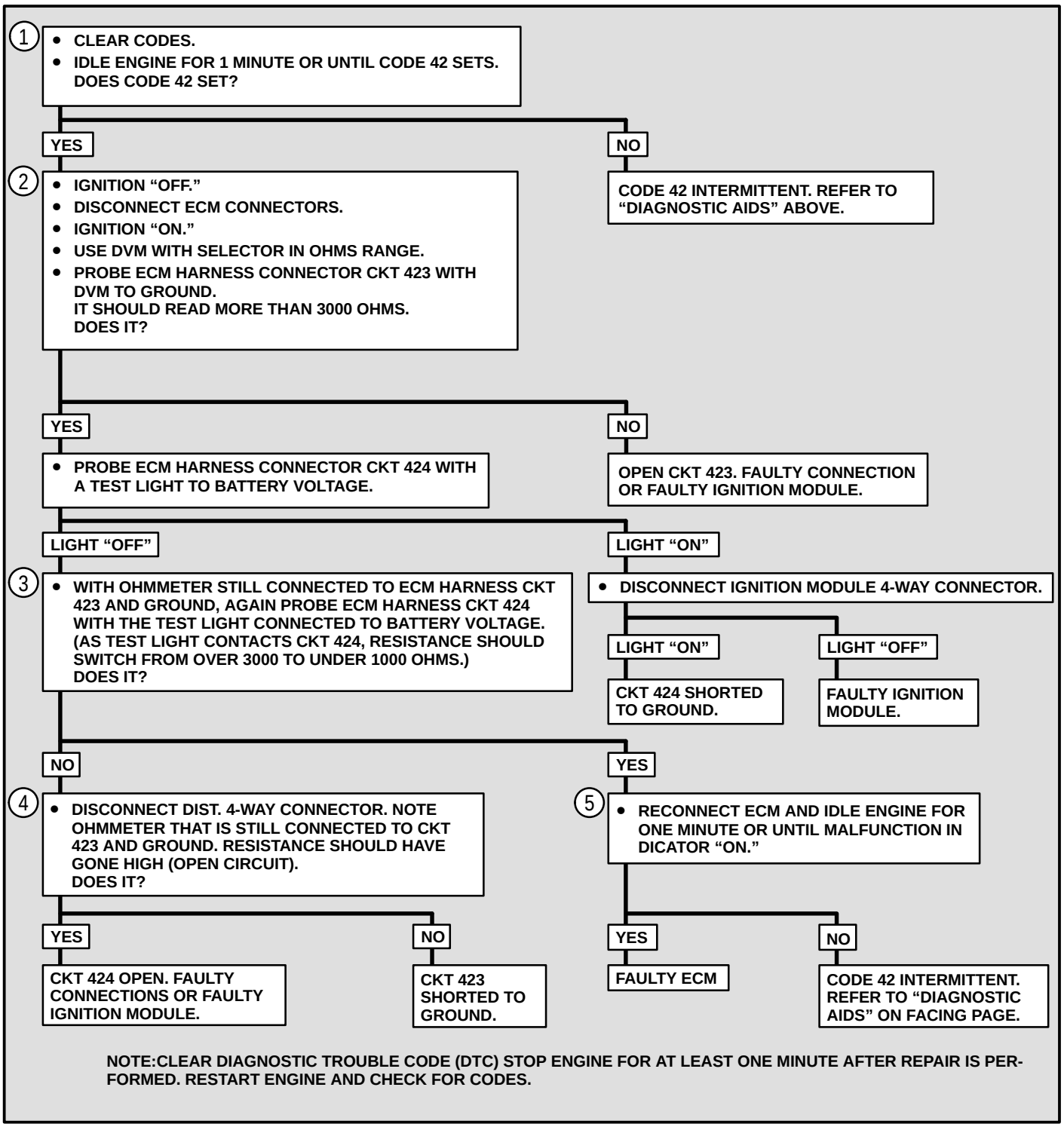
Code 42: IC Circuit (Scan) (2 of 2)

DIAGNOSTIC AIDS:

Refer to “Intermittents” in “Troubleshooting.”

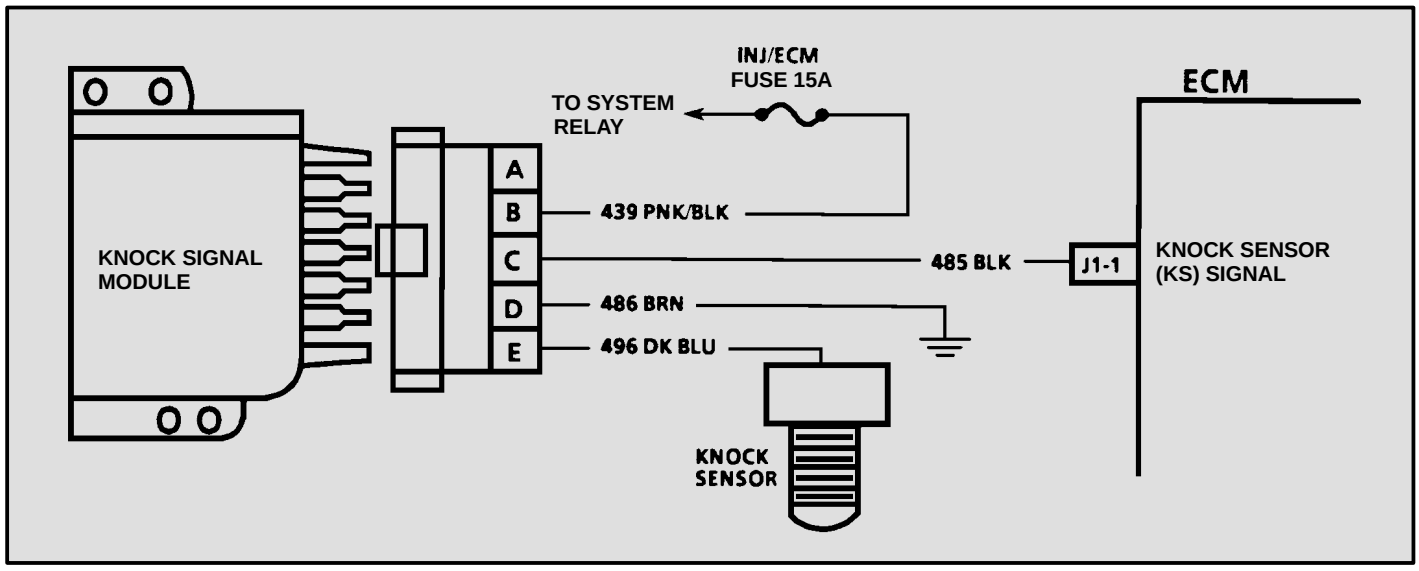
An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.


1
• CLEAR CODES.
• IDLE ENGINE FOR 1 MINUTE OR UNTIL CODE 42 SETS. DOES CODE 42 SET?
YES
NO
CODE 42 INTERMITTENT. REFER TO “DIAGNOSTIC AIDS” ABOVE.
2
• IGNITION “OFF.”
• DISCONNECT ECM CONNECTORS.
• IGNITION “ON.”
• USE DVM WITH SELECTOR IN OHMS RANGE.
• PROBE ECM HARNESS CONNECTOR CKT 423 WITH DVM TO GROUND. IT SHOULD READ MORE THAN 3000 OHMS. DOES IT?
YES
NO
• PROBE ECM HARNESS CONNECTOR CKT 424 WITH A TEST LIGHT TO BATTERY VOLTAGE.
OPEN CKT 423. FAULTY CONNECTION OR FAULTY IGNITION MODULE.
LIGHT “OFF”
LIGHT “ON”
3
• WITH OHMMETER STILL CONNECTED TO ECM HARNESS CKT 423 AND GROUND, AGAIN PROBE ECM HARNESS CKT 424 WITH THE TEST LIGHT CONNECTED TO BATTERY VOLTAGE. (AS TEST LIGHT CONTACTS CKT 424, RESISTANCE SHOULD SWITCH FROM OVER 3000 TO UNDER 1000 OHMS.) DOES IT?
• DISCONNECT IGNITION MODULE 4-WAY CONNECTOR.
LIGHT “ON”
LIGHT “OFF”
CKT 424 SHORTED TO GROUND.
FAULTY IGNITION MODULE.
NO
YES
4
• DISCONNECT DIST. 4-WAY CONNECTOR. NOTE OHMMETER THAT IS STILL CONNECTED TO CKT 423 AND GROUND. RESISTANCE SHOULD HAVE GONE HIGH (OPEN CIRCUIT). DOES IT?
5
• RECONNECT ECM AND IDLE ENGINE FOR ONE MINUTE OR UNTIL MALFUNCTION IN DICATOR “ON.”
YES
NO
YES
NO
CKT 424 OPEN. FAULTY CONNECTIONS OR FAULTY IGNITION MODULE.
CKT 423 SHORTED TO GROUND.
FAULTY ECM
CODE 42 INTERMITTENT. REFER TO “DIAGNOSTIC AIDS” ON FACING PAGE.
NOTE:CLEAR DIAGNOSTIC TROUBLE CODE (DTC) STOP ENGINE FOR AT LEAST ONE MINUTE AFTER REPAIR IS PERFORMED. RESTART ENGINE AND CHECK FOR CODES.

Index

Code 43: Knock Sensor (KS) (Scan)
(1 Of 2)



CIRCUIT DESCRIPTION:

Sensing engine detonation or spark knock is accomplished with a module that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage from the KS module to the ECM drops, and this signals the ECM to retard timing. The ECM will retard the timing when knock is detected and RPM is above a certain value.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step determines if there is a problem in the circuit. When an KS circuit fails, the ECM will switch to a default value of about 3.2 degrees of timing retard.
2. This step checks if there is a voltage source to the knock sensor from the KS module.
3. This step will determine if the knock sensor is faulty.

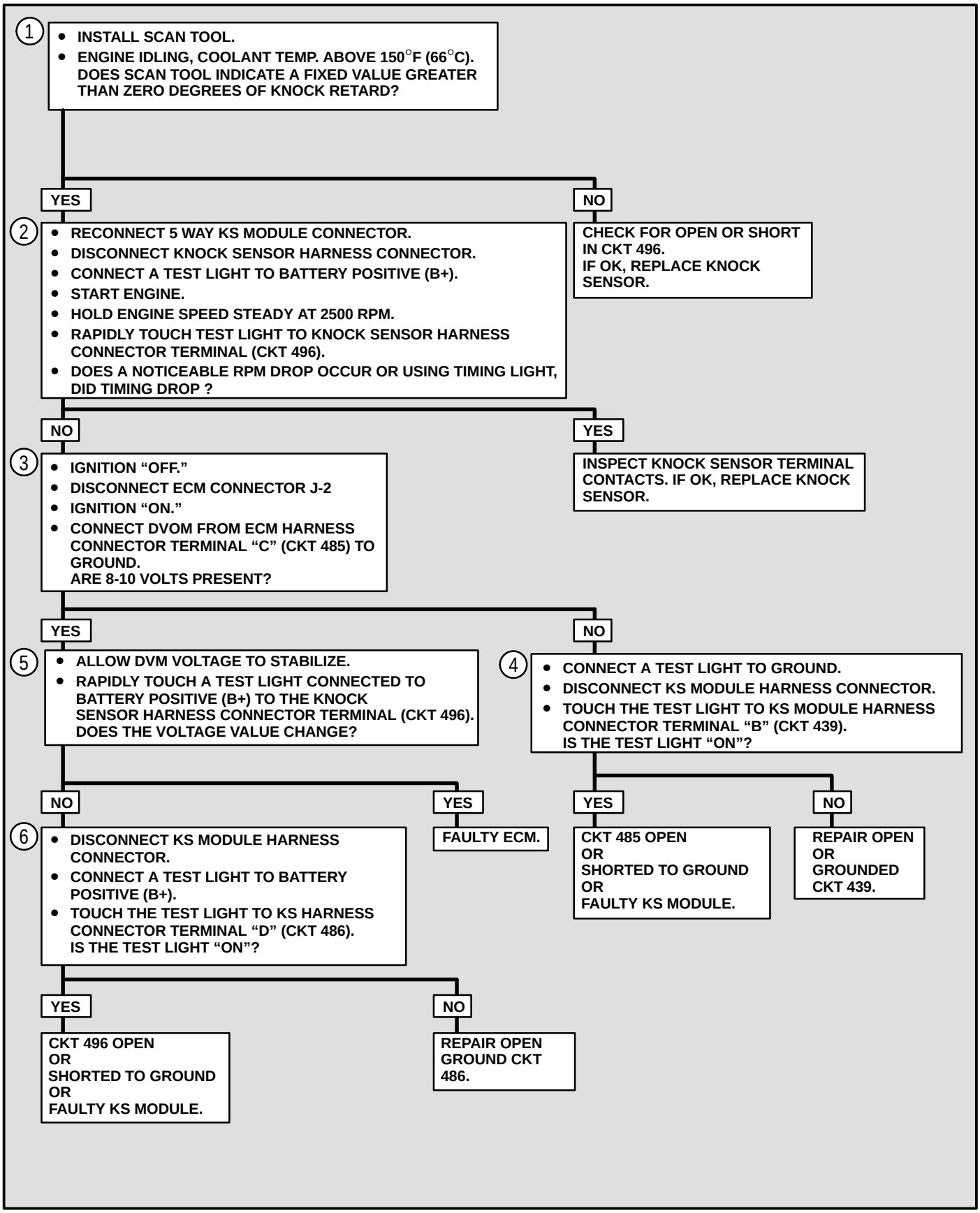
DIAGNOSTIC AIDS:

If CKT 496 is routed too close to secondary ignition wires, the KS module may see the interference as a knock signal, resulting in false retard.

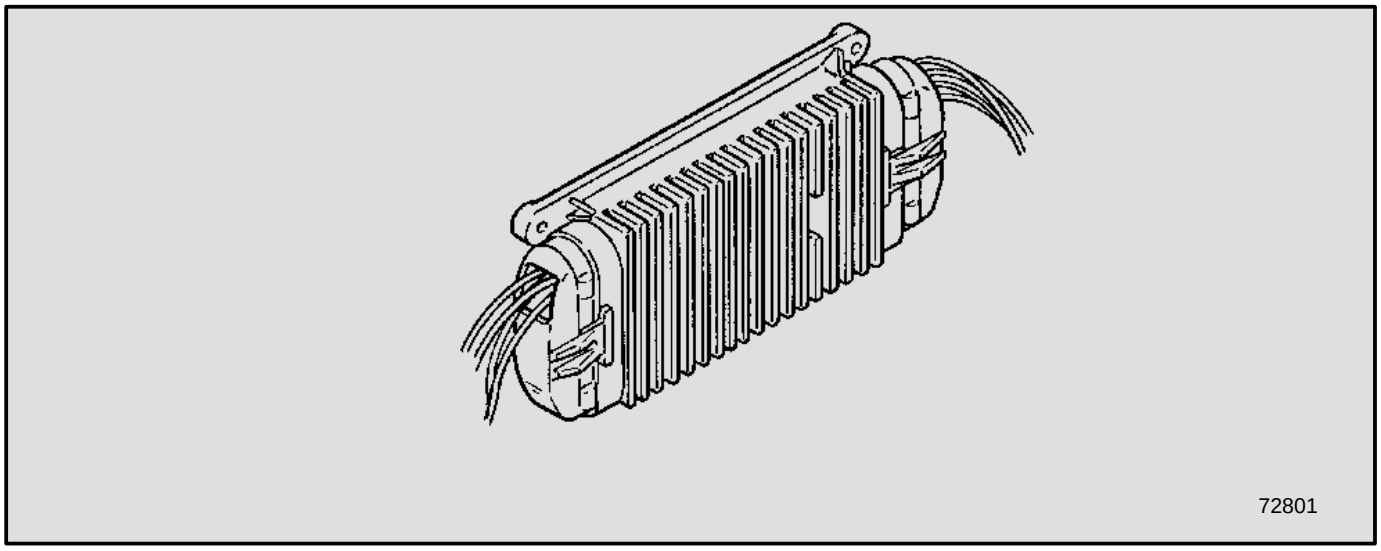
An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

Code 43: KS Circuit (Scan)
(2 of 2)


1
INSTALL SCAN TOOL.
ENGINE IDLING, COOLANT TEMP. ABOVE 150°F (66°C). DOES SCAN TOOL INDICATE A FIXED VALUE GREATER THAN ZERO DEGREES OF KNOCK RETARD?
YES
NO
2
RECONNECT 5 WAY KS MODULE CONNECTOR.
DISCONNECT KNOCK SENSOR HARNESS CONNECTOR.
CONNECT A TEST LIGHT TO BATTERY POSITIVE (B+).
START ENGINE.
HOLD ENGINE SPEED STEADY AT 2500 RPM.
RAPIDLY TOUCH TEST LIGHT TO KNOCK SENSOR HARNESS CONNECTOR TERMINAL (CKT 496).
DOES A NOTICEABLE RPM DROP OCCUR OR USING TIMING LIGHT, DID TIMING DROP ?
CHECK FOR OPEN OR SHORT IN CKT 496. IF OK, REPLACE KNOCK SENSOR.
NO
YES
3
IGNITION "OFF."
DISCONNECT ECM CONNECTOR J-2
IGNITION "ON."
CONNECT DVOM FROM ECM HARNESS CONNECTOR TERMINAL "C" (CKT 485) TO GROUND. ARE 8-10 VOLTS PRESENT?
INSPECT KNOCK SENSOR TERMINAL CONTACTS. IF OK, REPLACE KNOCK SENSOR.
YES
NO
5
ALLOW DVM VOLTAGE TO STABILIZE.
RAPIDLY TOUCH A TEST LIGHT CONNECTED TO BATTERY POSITIVE (B+) TO THE KNOCK SENSOR HARNESS CONNECTOR TERMINAL (CKT 496). DOES THE VOLTAGE VALUE CHANGE?
4
CONNECT A TEST LIGHT TO GROUND.
DISCONNECT KS MODULE HARNESS CONNECTOR.
TOUCH THE TEST LIGHT TO KS MODULE HARNESS CONNECTOR TERMINAL "B" (CKT 439). IS THE TEST LIGHT "ON"?
NO
YES
YES
NO
6
DISCONNECT KS MODULE HARNESS CONNECTOR.
CONNECT A TEST LIGHT TO BATTERY POSITIVE (B+).
TOUCH THE TEST LIGHT TO KS HARNESS CONNECTOR TERMINAL "D" (CKT 486). IS THE TEST LIGHT "ON"?
FAULTY ECM.
CKT 485 OPEN OR SHORTED TO GROUND OR FAULTY KS MODULE.
REPAIR OPEN OR GROUNDED CKT 439.
YES
NO
CKT 496 OPEN OR SHORTED TO GROUND OR FAULTY KS MODULE.
REPAIR OPEN GROUND CKT 486.

Code 51: Calibration Memory Failure (Scan) (1 Of 2)



CIRCUIT DESCRIPTION:

This test allows the ECM to check for a calibration failure by comparing the calibration value to a known value stored in the EEPROM.

This test is also used as a security measure to prevent improper use of calibrations or changes to these calibrations that may alter the designed function of EFI.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step checks to see if the fault is present during diagnosis. If present, the ECM is not functioning correctly and must be replaced.

IMPORTANT: At the time of printing, vessels with fuel injection were not being field reprogrammed to correct this failure. Replacement of the ECM with a factory reprogrammed ECM is necessary if Code 51 is current and resets when clearing codes is completed.

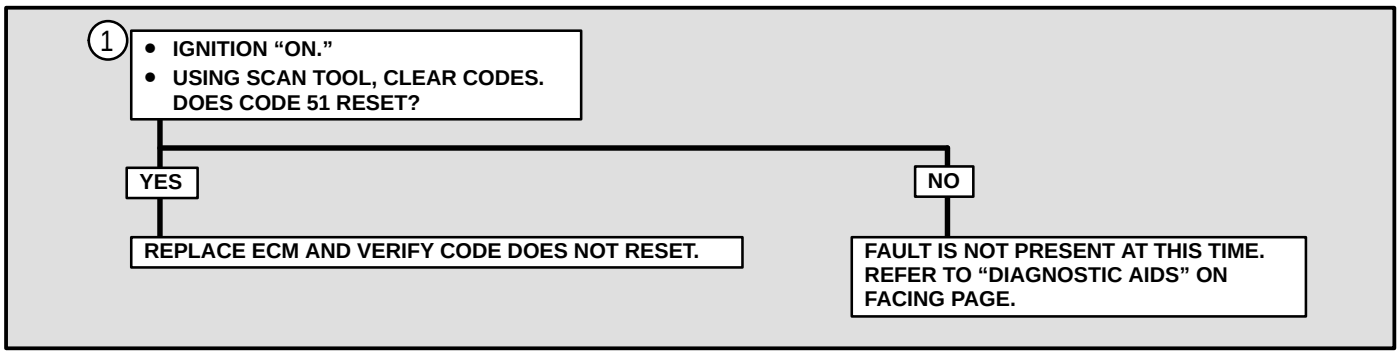
DIAGNOSTIC AIDS:

An intermittent Code 51 may be caused by a bad cell in the EEPROM that is sensitive to temperature changes. If Code 51 failed more than once, but is intermittent, replace ECM.

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

Code 51: Calibration Memory Failure (Scan) (2 of 2)


1
IGNITION "ON."
USING SCAN TOOL, CLEAR CODES. DOES CODE 51 RESET?
YES
NO
REPLACE ECM AND VERIFY CODE DOES NOT RESET.
FAULT IS NOT PRESENT AT THIS TIME. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

Troubleshooting

Changes In Terminology

Due to industry standardization of terminology for certain electronic engine controls some names and abbreviations have changed.

From	To
(CTS) Coolant Temperature Sensor	(ECT) Engine Coolant Temperature
(TPS) Throttle Position Sensor	(TP) Throttle Position
(MAT) Manifold Air Temperature	(IAT) Intake Air Temperature
(EST) Electronic Spark Timing	(IC) Ignition Control
(ESC) Electronic Spark Control	(KS) Knock Sensor
(ALDL) Assembly Line Data Link	(DLC) Data Link Connector

Diagnostic Trouble Codes

Code Number	Code Description
Code 14	(ECT) Engine Coolant Temperature
Code 21	(TP) Throttle Position Sensor
Code 23	(IAT) Intake Air Temperature
Code 33	(MAP) Manifold Absolute Pressure
Code 42	(IC) Ignition Control
Code 43	(KS) Knock Sensor
Code 51	Calibration Memory Failure

Important Preliminary Checks

Before using this section, you should verify the customer complaint, and locate the correct symptom. Check the items indicated under that symptom.

Several of the following symptom procedures call for a careful visual/physical check.

The importance of this step cannot be stressed too strongly, it can lead to correcting a problem without further checks and can save valuable time.

1. Ensure that engine is in good mechanical condition.
2. Vacuum hoses for splits, kinks and proper connections
3. Air leaks at throttle body, plenum and intake manifold.
4. Ignition wires for cracking, hardness and proper routing.
5. Wiring for proper connections, pinches, and cuts. If wiring harness or connector repair is necessary.

Troubleshooting Charts

IMPORTANT PRELIMINARY CHECKS

BEFORE USING THIS SECTION

Before using this section you should have performed the “EFI Diagnostic Circuit Check” and determined that:

1. The ECM is operating correctly.
2. There are no diagnostic trouble codes (DTC) stored.

SYMPTOM

Verify the customer complaint, and locate the correct symptom. Check the items indicated under that symptom.

VISUAL/PHYSICAL CHECK

Several of the symptom procedures call for a careful visual/physical check. The importance of this step cannot be stressed too strongly. It can lead to correcting a problem without further checks and can save valuable time. These checks should include:

1. ECM grounds and sensors for being clean, tight and in their proper locations.
2. Vacuum hoses for splits, kinks, and proper connections. Check thoroughly for any type of leak or restriction.
3. Air leaks at throttle body mounting area and intake manifold sealing surfaces.
4. Ignition wires for cracking, hardness, proper routing and carbon tracking.
5. Wiring for proper connections, pinches and cuts.
6. Moisture in distributor cap, primary or secondary ignition circuit connections.
7. Salt corrosion on electrical connections and exposed throttle body linkages.
8. Ensure engine is in good mechanical condition.

INTERMITTENTS

Definition: Problem occurs randomly. May or may not store a Diagnostic Trouble Code (DTC).

DO NOT use the diagnostic trouble code charts for intermittent problems, unless instructed to do so. If a fault is intermittent, incorrect use of diagnostic trouble code charts may result in replacement of good parts.

Most intermittent problems are caused by faulty electrical connections or wiring. Perform careful check of suspected circuits for:

1. Poor mating of the connector halves or terminals not fully seated in the connector body (backed out or loose).
2. Improperly formed or damaged terminals and or connectors. All connector terminals and connectors in problem circuit should be carefully reformed or replaced to insure proper contact tension.
3. Poor terminal to wire connection (crimping).

An intermittent may be caused by:

1. Electrical system interference caused by a sharp electrical surge. Normally, the problem will occur when the faulty component is operated.
2. Improper installation of electrical options, such as lights, ship to shore radios, sonar, etc.
3. Improperly routed knock sensor wires. Wires should be routed **AWAY** from spark plug wires, ignition and charging system components.
4. Secondary ignition shorted to ground.
5. Arching at spark plug wires, spark plugs or open ignition coil ground (coil mounting brackets). Part of internal circuitry shorted to ground such as in starters, relays and alternators.

If a visual/physical check does not find the cause of the problem, the EFI system can be tested with a voltmeter or a scan tool connected while observing the suspected circuit. An abnormal reading, when the problem occurs, indicates the problem may be in that circuit.

HARD START

Definition: Engine cranks OK, but does not start for a long time. Engine does eventually run, or may start but immediately dies.

PRELIMINARY CHECKS

Make sure proper starting procedure is being used. See Owner's Manual.

Perform the careful visual/physical checks as described at the start of "Troubleshooting Charts" section.

CHECK FUEL SYSTEM FOR:

1. Proper operation of fuel pump relay. Relay will operate fuel pump for 2 seconds when ignition is turned "ON." Also look for open in CKT 465, fuel pump relay driver.
2. Clogged or dirty water separating fuel filter.
3. Contaminated fuel or winter grade fuel during warm weather.
4. Vapor lock condition or engine flooding. Check fuel pressure.
5. VST fault-stuck float, leaking vapor regulator.
6. Electric fuel pump check valve or fuel pressure regulator and / or fuel damper leaking.

CHECK IGNITION SYSTEM FOR:

1. Proper ignition timing.
2. Ignition wires for cracking, hardness and proper connections at both distributor cap and spark plugs.
3. Wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary.
4. Distributor cap inside and out for moisture, dust, cracks, burns, and arcing to coil mounting screws.
5. Worn distributor shaft. Bare and shorted wires. Pick-up coil resistance and connections. Try to turn distributor shaft by hand. Drive pin may be broken.

HARD START (continued)

CHECK SENSORS AND CONTROLS FOR:

1. Possible open in Engine Coolant Temperature (ECT) sensor and Manifold Absolute Pressure (MAP) sensor Ground CKT 814. Also may have set a DTC 14 and/or DTC 33.
2. Throttle Position (TP) sensor,ground CKT 813 could have a possible open and set DTC 21.
3. A sticking throttle shaft or binding linkage causes a high Throttle Position (TP) sensor voltage. Using a scan tool and/or voltmeter, TP sensor voltage should read less than .7 volt with throttle closed.
4. Proper Idle Air Control (IAC) operation.

CHECK ENGINE FOR:

1. Restricted exhaust.
2. Proper cylinder compression.
3. Proper camshaft timing/valve train problem.

SURGES

Definition: Engine power variation under steady throttle or cruise. Feels like the engine speeds up and slows down with no change in the throttle control.

PRELIMINARY CHECKS

Perform the visual/physical checks as described at the start of “Troubleshooting Charts” section.

CHECK FUEL SYSTEM FOR:

1. Fuel pressure to be within specification while condition exists.

CHECK IGNITION SYSTEM FOR:

1. Condition of 4-terminal Ignition Control (IC) connector at distributor. Connector wires must not be routed near spark plug wires.
2. Intermittent ground connection on ignition coil.
3. Proper operation (advancing or retarding) of Ignition Control (IC).
4. Condition of distributor cap, rotor, and spark plug wires.
5. Proper and clean connection on distributor pick-up coil terminal.
6. Spark plugs that may be fuel fouled, cracked, worn, improperly gapped, burned electrodes, or heavy deposits. Repair or replace as necessary.

CHECK SENSORS AND CONTROLS FOR:

1. Intermittent opens in Manifold Absolute Pressure (MAP) or Engine Coolant Temperature (ECT) sensor grounds CKT 814. If intermittent for a very brief period, will not set DTC.
2. Intermittent short to grounds or opens in Manifold Absolute Pressure (MAP) sensor 5 volt reference CKT 416 and Manifold Absolute Pressure (MAP) sensor signal CKT 432. If intermittent for a very brief period, will not set DTC.

SURGES (continued)

ADDITIONAL CHECKS FOR:

1. Proper alternator output voltage.
2. Leaks or kinks in vacuum lines.
3. Power reduction mode activated (if equipped)
4. Clean and tight ECM grounds and in their proper locations.

HESITATION, SAG OR STUMBLE

Definition: Momentary lack of response as the throttle is opened. Can occur at all engine speeds. May cause engine to stall if severe enough.

PRELIMINARY CHECKS

Perform the visual/physical checks as described at the start of “Troubleshooting Charts” section.

CHECK FUEL SYSTEM FOR:

1. Water contaminated fuel and dirty or restricted fuel filter
2. Fuel pressure within specification.
3. Proper functioning of fuel injectors.
4. Worn throttle linkage.

CHECK IGNITION SYSTEM FOR:

1. Ignition Control (IC) system for proper timing and advancing.
2. Faulty spark plug wires, fouled or improperly gapped spark plugs.
3. Power reduction mode activated (if equipped)
4. Knock Sensor (KS) system operational.

HESITATION, SAG OR STUMBLE (continued)

CHECK SENSORS AND CONTROLS FOR:

1. Binding or sticking Throttle Position (TP) sensor or salt corrosion. Throttle Position (TP) sensor voltage should increase as throttle is moved toward Wide Open Throttle (WOT).
2. Throttle Position (TP) sensor-5 volt reference CKT 416 for open, DTC 21 may be set.
3. Throttle Position (TP) sensor circuit for open or grounds, DTC 21 may be set.
4. Manifold Absolute Pressure (MAP) output voltage check.
5. Coolant sensor out of specification (Hi or low)

ADDITIONAL CHECKS

1. Proper alternator output voltage.
2. Faulty or incorrect thermostat.
3. Throttle linkage sticking, binding, or worn.

DETONATION/SPARK KNOCK

Definition: A mild to severe ping, usually worse under acceleration or heavy load. The engine makes sharp metallic knocks that change with throttle opening.

PRELIMINARY CHECKS

Perform the visual/physical checks as described at the start of “Troubleshooting Charts” section.

CHECK FUEL SYSTEM FOR:

1. Contaminated fuel.
2. Poor fuel quality and proper octane rating.
3. Fuel pressure within specification.

CHECK IGNITION SYSTEM FOR:

1. Proper ignition timing.
2. Proper operation of Knock Sensor (KS) system. Ensure wires are routed **AWAY** from secondary or primary ignition wires.
3. Ignition system ground.
4. Proper heat range and gapped spark plugs.
5. Incorrect knock sensor or knock sensor module.

CHECK SENSORS AND CONTROLS FOR:

1. Engine Coolant temperature (ECT) has shifted value.
2. Binding or sticking Throttle Position (TP) sensor or salt corrosion. Voltage should increase as throttle is moved toward Wide Open Throttle (WOT).

DETONATION/SPARK KNOCK (continued)

CHECK ENGINE FOR:

1. Low oil level.
2. Excessive oil in the combustion chamber. Valve seals for leaking.
3. Perform a compression test.
4. Combustion chambers for excessive carbon build-up. Remove carbon with top engine cleaner.
5. Proper camshaft timing.
6. Incorrect basic engine parts such as cam, heads, pistons, etc.

LACK OF POWER, SLUGGISH OR SPONGY

Definition: Engine delivers less than expected power. Little or no increase in speed when throttle control is moved toward Wide Open Throttle (WOT).

PRELIMINARY CHECKS

Perform the careful visual/physical checks as described at the start of “Troubleshooting Charts” section.

Remove flame arrestor and check for dirt, or for being plugged. Replace as necessary.

CHECK FUEL SYSTEM FOR:

1. Dirty or plugged water separating fuel filter.
2. Contaminated fuel
3. Possible open in injector driver CKTs 467 or 468.
4. Improper fuel pressure.
5. Flooded VST (if equipped)

CHECK IGNITION SYSTEM FOR:

1. Proper initial engine timing.
2. Secondary ignition voltage.
3. Proper operation of Ignition Control (IC)/Knock Sensor (KS),open or short to ground in CKT 423 or 485 will set a DTC 42 or 43.

LACK OF POWER, SLUGGISH OR SPONGY (continued)

CHECK SENSORS AND CONTROLS FOR:

1. Possible open in Engine Coolant Temperature (ECT) and Manifold Absolute Pressure (MAP) sensors (Ground CKT 814). Also could have and set a DTC 14 and/or 33.
2. Throttle Position (TP) sensor circuit if DTC 21 set for open or grounds.
3. Using a scan tool and/or voltmeter record Throttle Position (TP) sensor voltage. It should read less than .7 volt with throttle closed or at idle position. A sticky throttle shaft or binding linkage causes a high voltage
4. Power reduction mode activated.
5. Diagnostic test CKT 451 for being grounded, (maximum RPMs be will lower).

CHECK ENGINE FOR:

1. Restricted exhaust system.
2. Proper cylinder compression.
3. Proper valve timing and worn camshaft.

ADDITIONAL CHECKS:

1. Proper alternator output voltage..
2. Clean, tight and properly located ECM grounds.
3. Excessive resistance on bottom of boat (dirt, barnacles, etc.).
4. Proper size and pitch propeller for application.

CUTS OUT AND MISSES

Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases.

PRELIMINARY CHECKS

Perform the important preliminary checks as described at the start of the “Troubleshooting Charts” section

CHECK IGNITION SYSTEM FOR:

1. Cylinder miss

   a. Start engine, allow engine to stabilize, record RPM, then disconnect IAC motor. Stop engine, ground one spark plug wire at a time. Restart engine and record RPM.

   b. If there is an RPM drop on all cylinders, go to “Stalling, Rough, or Incorrect Idle” section. With engine “OFF” reconnect IAC motor

   c. If there is no RPM drop on one or more cylinders, or excessive variation in RPM drop, check for spark on the suspected cylinder(s).

   d. If there is a spark, remove spark plug(s) in these cylinders and check for: Insulation cracks, insulator cracks,wear, improper gap, burned electrodes, heavy deposits.

   e. Spark plug wire resistance (should not exceed 30,000 ohms).

   f. Faulty ignition coil.

   g. With engine running, spray distributor cap and spark plug wires with a fine mist of water to check for shorts.

CHECK FUEL SYSTEM FOR:

1. Contaminated or restricted water separating fuel filter.

2. Fuel pressure within specification. (Fuel pressure can be checked on fuel rail at the schrader valve. Mechanical pump can be checked with a carburetor fuel pressure gauge downstream from the pump prior to VST.

3. Faulty fuel injectors.

CUTS OUT AND MISSES (continued)

CHECK SENSORS AND CONTROLS FOR:

1. Open or grounds in CKT 417 Throttle Position (TP) sensor signal.
2. Open or grounds in CKT 416 Throttle Position (TP) sensor 5 volt reference.

CHECK ENGINE MECHANICAL FOR:

1. Proper cylinder compression.
2. Bent push rods, worn rocker arms, broken valve springs, worn camshaft lobes. Repair or replace as necessary.

ADDITIONAL CHECKS:

A miss-fire can be caused by Electromagnetic Interference (EMI) on the reference circuit. EMI can usually be detected by monitoring engine RPM with a scan tool or a tachometer. A sudden increase in RPM with little change in actual engine RPM change, indicates EMI is present. If the problem exists, check routing of secondary wires, check ground circuit.

ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING

Definition: Engine runs unevenly or rough at idle, also the idle may vary in RPM (called hunting). Either condition may be severe enough to cause stalling. Engine idles at incorrect speed.

PRELIMINARY CHECKS

Perform the important preliminary checks as described at the start of"Troubleshooting Charts" section.

CHECK FUEL SYSTEM FOR:

1. Open in CKTs 467 or 468.
2. Fuel injector(s) leaking.

CHECK IGNITION SYSTEM FOR:

1. Correct ignition timing
2. Possible opens in the following circuits, CKTs 424,430 and 423.
3. Possible short to ground in the following circuits, CKTs 430, 424, and 423.
4. Faulty spark plugs, wires, etc.

ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING (continued)

CHECK SENSORS AND CONTROLS FOR:

1. Proper Idle Air Control (IAC) operation.
2. Possible open the in following circuits for CKTs 410, 417, 416, 813 and 814.
3. Possible short to ground in CKT 417, Throttle Position (TP) sensor signal, CKT 416 Throttle Position (TP) sensor 5 volt reference and CKT 451 diagnostic test circuit.
4. A sticking throttle shaft, binding linkage or salt corrosion will cause a high Throttle Position (TP) sensor voltage (open throttle indication), the ECM will not control idle. Using a scan tool or voltmeter record Throttle Position (TP) sensor voltage. It should read approximately .7 volt closed throttle and approximately 4.5 volts at Wide Open Throttle (WOT).

CHECK ENGINE FOR:

1. Proper cylinder compression.
2. Proper camshaft or weak valve springs

ADDITIONAL CHECKS:

1. Sticking or binding throttle linkage and salt corrosion.
2. Proper alternator output voltage.
3. Battery cables and ground straps should be clean and secure. Erratic voltage will cause Idle Air Control (IAC) to change its position, resulting in poor idle quality.

BACKFIRE (INTAKE)

Definition: Fuel ignites in the manifold, making a loud popping noise.

PRELIMINARY CHECKS

Perform the important preliminary checks as described at the start of “Troubleshooting Charts” section.

CHECK FUEL SYSTEM FOR:

1. An abnormal fuel system condition: If necessary perform fuel system diagnosis.
2. Properly functioning fuel injectors.

CHECK IGNITION SYSTEM FOR:

1. Opens and grounds in CKTs 423, 424 and 430.
2. Proper output voltage of ignition coil.
3. Cross-fire between spark plugs, (distributor cap, spark plug wires and proper routing of plug wires).
4. Faulty or corroded spark plug wires and boots.
5. Faulty spark plugs.
6. Power reduction mode activated. (1996 Models and Older)

CHECK ENGINE FOR:

1. Sticking or leaking valves.
2. Proper valve timing, broken or worn valve train parts.

BACKFIRE (EXHAUST)

Definition: Fuel ignites in the manifold, making a loud popping noise.

PRELIMINARY CHECKS

Perform the important preliminary checks as described at the start of “Troubleshooting” section.

CHECK FUEL SYSTEM FOR:

1. An abnormal fuel system condition: If necessary perform fuel system diagnosis.
2. Proper functioning of fuel injectors.

CHECK IGNITION SYSTEM FOR:

1. Opens and grounds in CKTs 423, 424 and 430.
2. Properly functioning (advancing and retarding of timing) Ignition Control (IC).
3. Proper output voltage of ignition coil.
4. Faulty or corroded spark plug wires and boots.
5. Faulty spark plugs.

CHECK ENGINE FOR:

1. Possible sticking or leaking valves.

DIESELING, RUN-ON

Definition: Engine continues to run after key is turned "OFF," but runs very roughly. If engine runs smoothly, check ignition switch and adjustment.

PRELIMINARY CHECKS

Perform the important preliminary checks as described at the start of"Troubleshooting" section.

CHECK FUEL SYSTEM FOR:

1. Leaking injectors.
2. Flooded VST

CHECK IGNITION SYSTEM FOR:

1. Properly functioning (advancing and retarding of timing) Ignition Control (IC).
2. Correct heat range spark plugs.
3. Proper operation of system relay.

CHECK COOLING SYSTEM FOR:

1. Faulty or incorrect thermostat.
2. Cooling system restriction causing overheating.
3. Loose belts.

POOR FUEL ECONOMY

Definition: Fuel economy is noticeably lower than expected.

PRELIMINARY CHECKS

Perform the important preliminary checks as described at the start of “Troubleshooting” section.

1. Operator’s driving habits.
2. Dirty or plugged flame arrestor.
3. Fuel leaks.

CHECK FUEL SYSTEM FOR:

1. Quality and type of fuel.
2. Flooded VST.
3. Fuel pressure within specification.

CHECK IGNITION SYSTEM FOR:

1. Correct base timing
2. Properly functioning (advancing and retarding of timing) Ignition Control (IC).
3. Fuel fouled, cracked, worn, improperly gapped spark plugs, burned electrodes, or heavy deposits. Repair or replace as necessary.
4. Knock sensor system operation.

POOR FUEL ECONOMY (continued)

CHECK SENSORS AND CONTROLS FOR:

1. If MAP, TP, or Coolant Sensor are erratic there will be poor economy.

CHECK ENGINE FOR:

1. Proper cylinder compression.

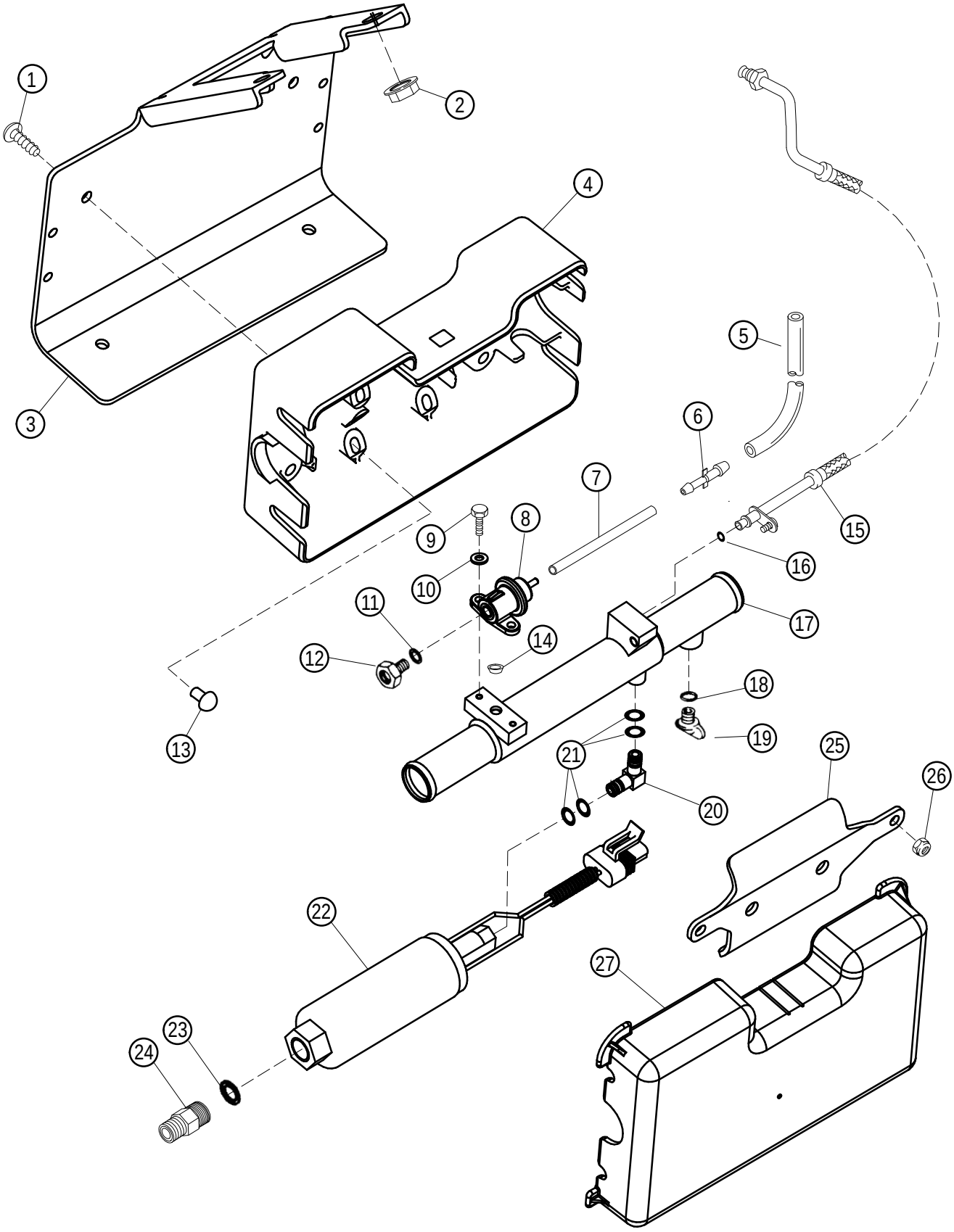
1. Exhaust system restriction.

2. Excessive resistance on bottom of boat (dirt, barnacles, etc.)

3. Proper size and pitch propeller for application.

Fuel Delivery Systems

Cool Fuel System Exploded View



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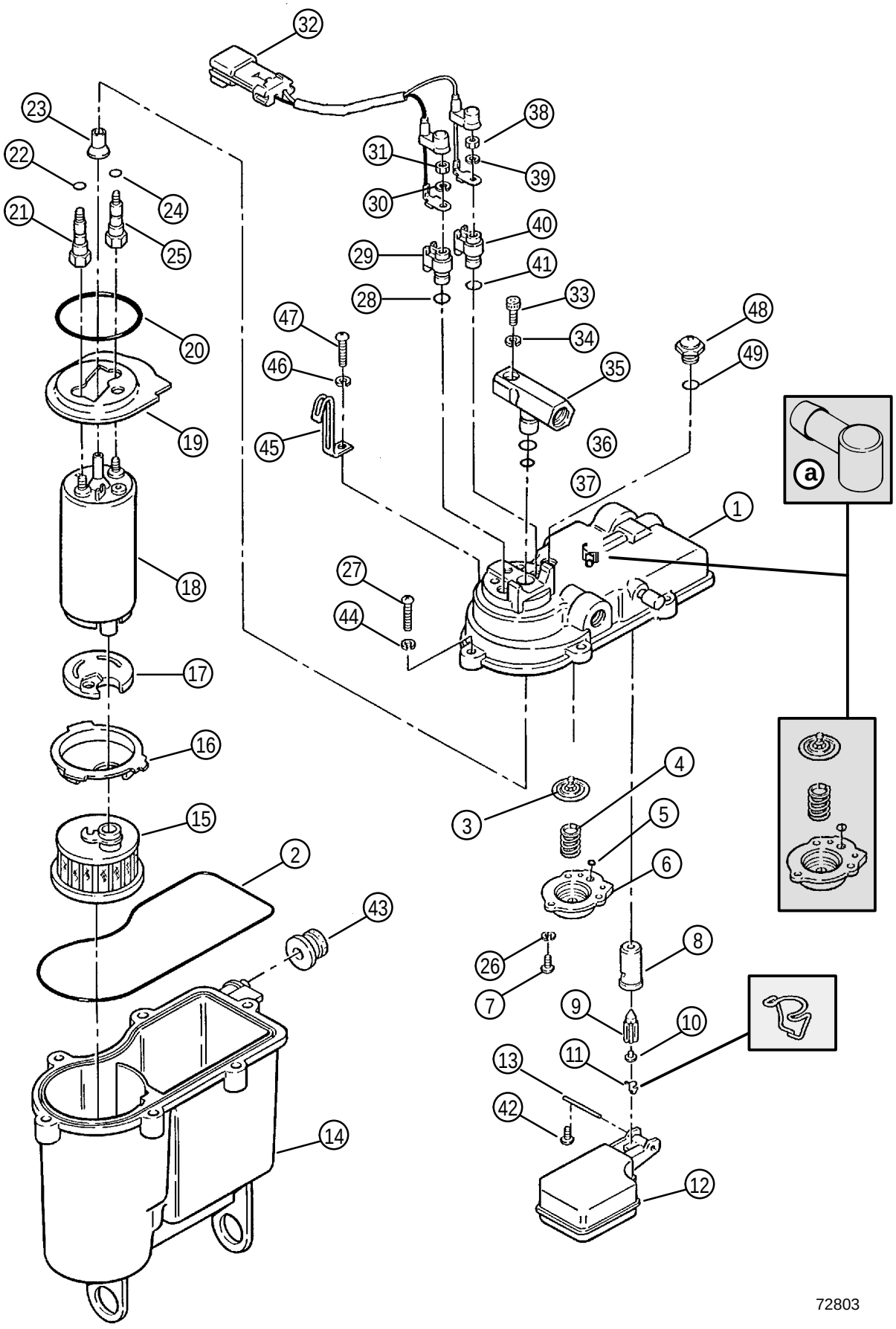
17-Fuel Cooler
18-O-Ring
19-Drain Plug
20-Elbow Fitting
21-O-Rings (4)
22-Electric Fuel Pump
23-O-Ring
24-Fuel Pump Inlet Fitting
25-Retainer Bracket
26-Nut (2)
27-Cover

Vapor Separator Tank (VST) Exploded View

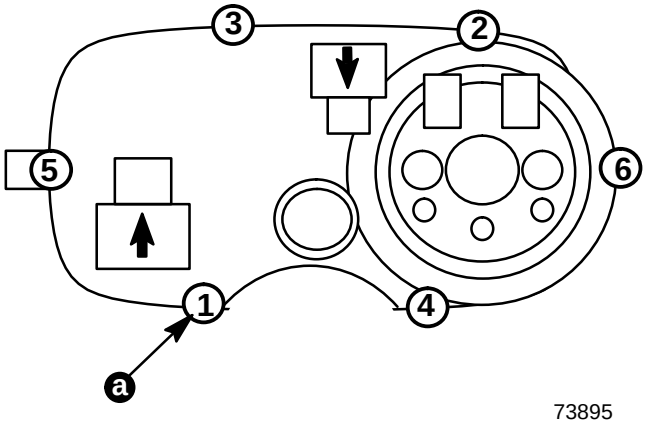


Index

1 -Cover
2 -Seal
3 -Spring
4 -Diaphragm
5 -O-ring
6 -Diaphragm Cover
7 -Screw
8 -Valve Seat
9 -Float Valve
10-Float Valve Pin
11-Clip
12-Float
13-Float Arm Pin
14-VST Body
15-Fuel Screen
16-Plate
17-Rubber Cushion
18-Electric Fuel Pump
19-Plate
20-O-ring
21-Adapter
22-O-ring
23-Collar
24-O-ring
25-Adapter
26-Lockwasher
27-Screw
28-O-ring
29-Insulator
30-Lockwasher
31-Nut
32-Electrical Connector
33-Screw
34-Lockwasher
35-L-Joint
36-O-ring
37-O-ring
38-Nut
39-Lockwasher
40-Insulator
41-O-ring
42-Screw
43-Grommet
44-Lockwasher
45-Clip
46-Lockwasher
47-Screw
48-Plug
49-O-ring

a - A VST equipped with elbow fitting on top of VST will have this configuration diaphragm and spring.

Torque Sequence For VST



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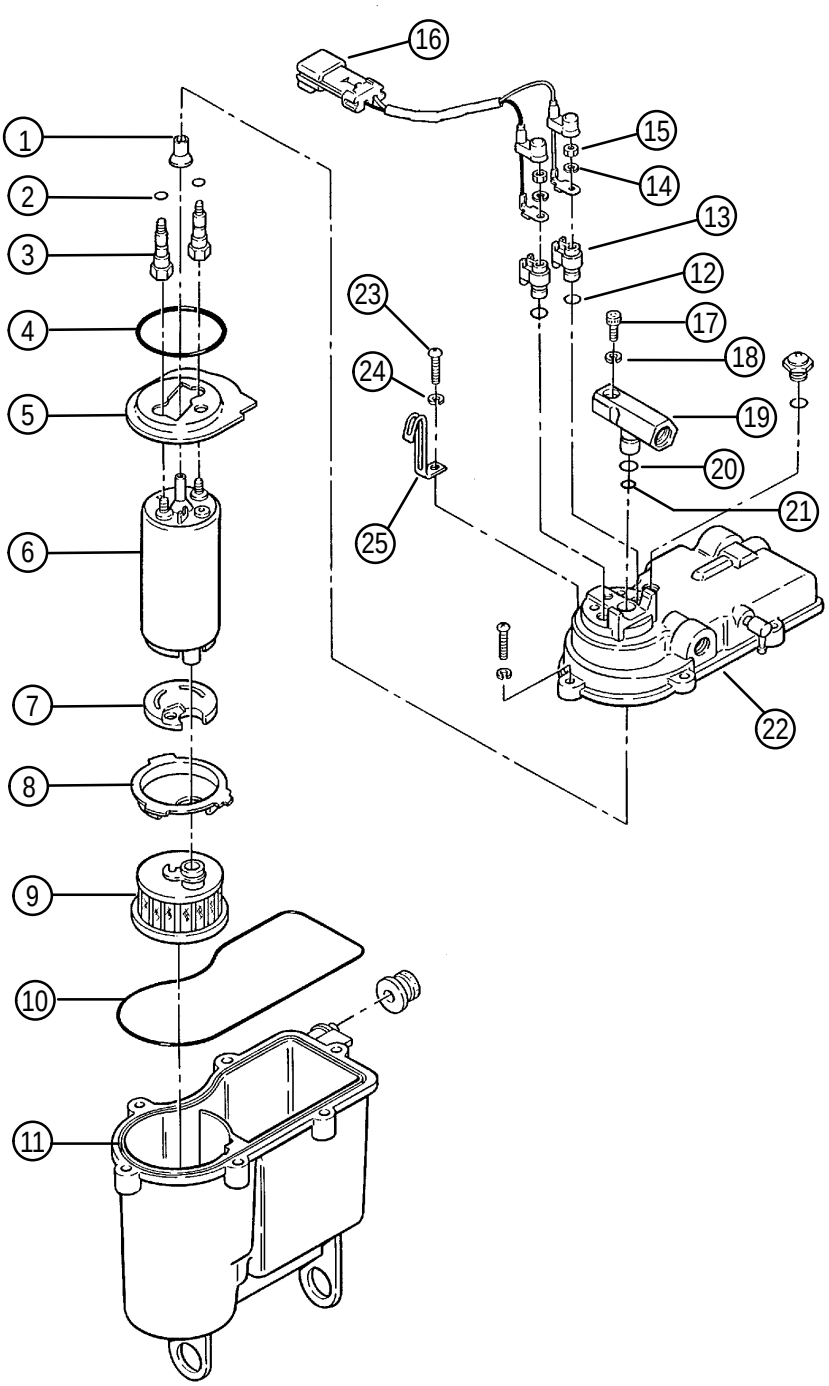
a - Tighten Screws Securely

VST Fuel Pump (Exploded View)



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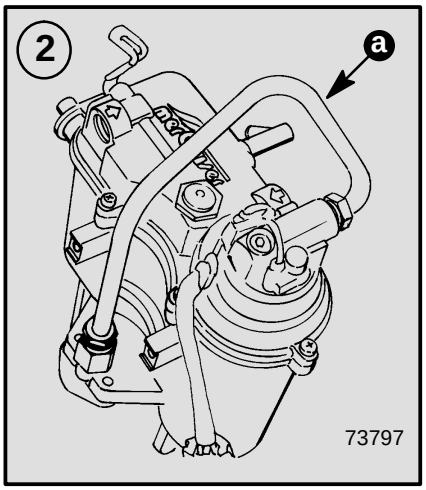
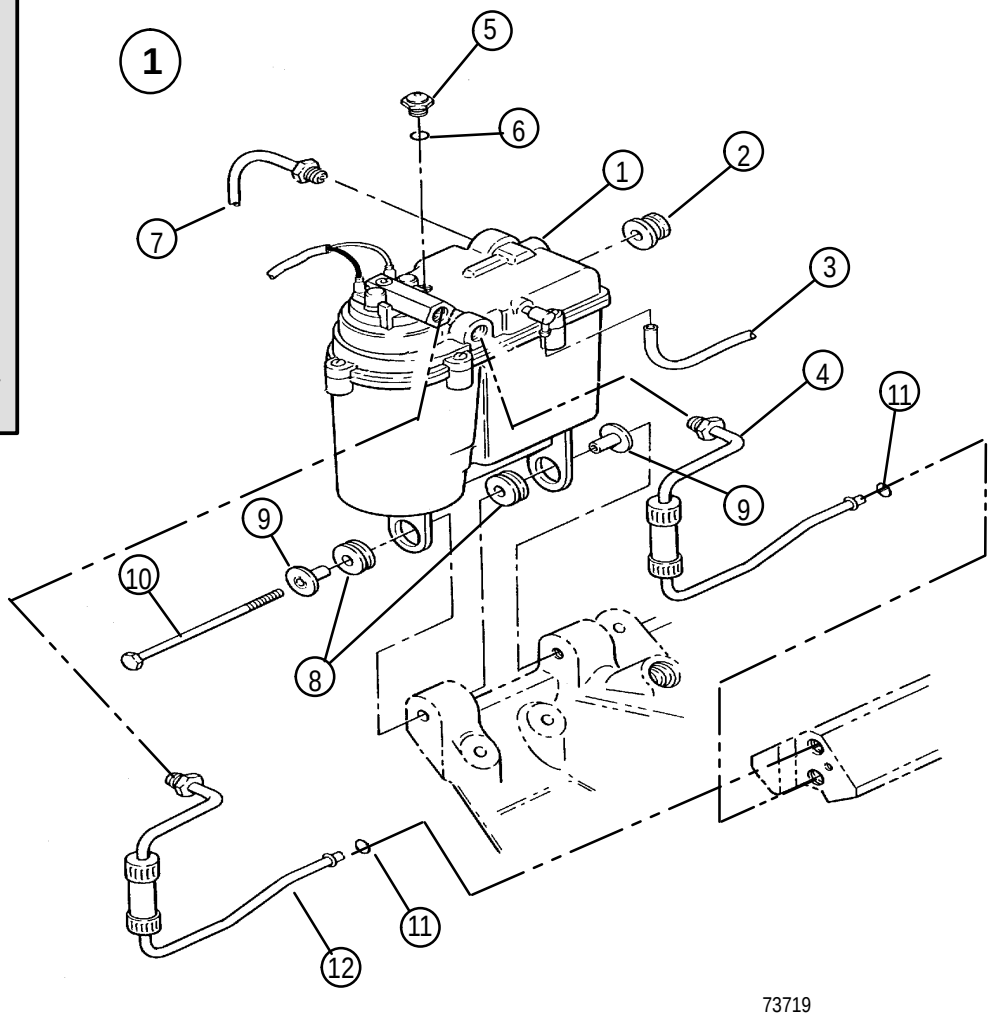
1 - Collar
2 - O-Rings (2)
3 - Adapters (2)
4 - O-Ring
5 - Plate
6 - Electric Fuel Pump
7 - Rubber Cushion
8 - Plate
9 - Fuel Filter
10- Seal
11- Chamber Body
12- O-Rings (2)
13- Insulators (2)
14- Lockwashers (2)
15- Nuts (2)
16- Electrical Connector
17- Screw
18- Spring Washer
19- L-Joint
20- O-Ring
21- O-Ring
22- Cover
23- Screws (6)
24- Lockwashers (6)
25- Clip

Index

VAPOR SEPARATOR TANK (VST)





NOTE: *Later model VST* ***(MCM 454 Magnum EFI Serial Number-0F130438 and MCM 502 Magnum EFI Serial Number 0F128962 and higher)*** *will be equipped with the fuel line as shown. Earlier VSTs will have fuel lines as shown in figure 2.*

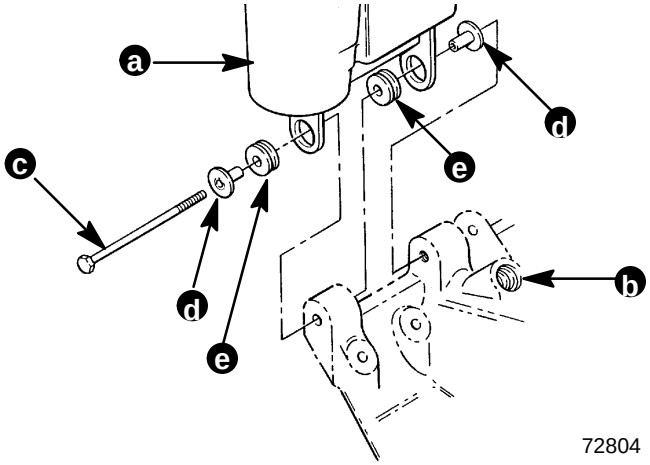
1 - Vapor Separator Tank (VST)
2 - Grommet
3 - Hose
4 - Fuel Line Return
5 - Plug
6 - O-Ring
7 - Fuel Line VST Supply
8 - Grommet
9 - Bushing
10- Screw
11- O-Ring
12- Fuel Line Supply

Vapor Separator Tank (VST)

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Disconnect fuel pump electrical connector.
2. Label and then disconnect all fuel lines from cover of vapor separator tank.



a - VST
b - Intake Manifold
c - Screw
d - Bushing
e - Grommet

3. Remove screw and VST from intake manifold.

INSTALLATION

1. Install VST to intake manifold. Apply Loctite 8831 to threads of attaching screw. Torque bolt to 105 lb. in. (12 N·m).
2. Connect all lines to cover of vapor separator tank. Torque fuel line fittings to 23 lb. ft. (31 N·m).
3. Connect fuel pump electrical connector.
4. With engine off, cycle ignition switch to on,waiting 2 seconds and then off, four times waiting 10 seconds after each key off to prime the fuel system and check for leaks.

NOTE: *If VST is dry, remove the vent screw and fill with fuel.*

REMOVAL - VST FUEL PUMP

1. Disconnect fuel pump electrical connector.
2. Label and then disconnect all lines from cover of vapor separator tank.
3. Remove electrical line from retaining clip.
4. Remove screw from L-joint and pull L-joint from cover.
5. Disconnect fuel pump electrical connectors as follows:
   a. Gently pry each side of connector cover up and over retaining tabs.
   b. Remove connector retaining nuts and remove connectors.
6. Remove cover screws and remove cover and electrical line retaining clip.
7. Carefully slide fuel pump assembly from cover.
8. Remove O-ring, plate, adaptors and collar from fuel pump.
9. Remove screen from fuel pump.
10. Remove plate and rubber cushion.

NOTE: *When replacing fuel pump, make certain to replace with a fuel pump of the identical part number.*

INSTALLATION

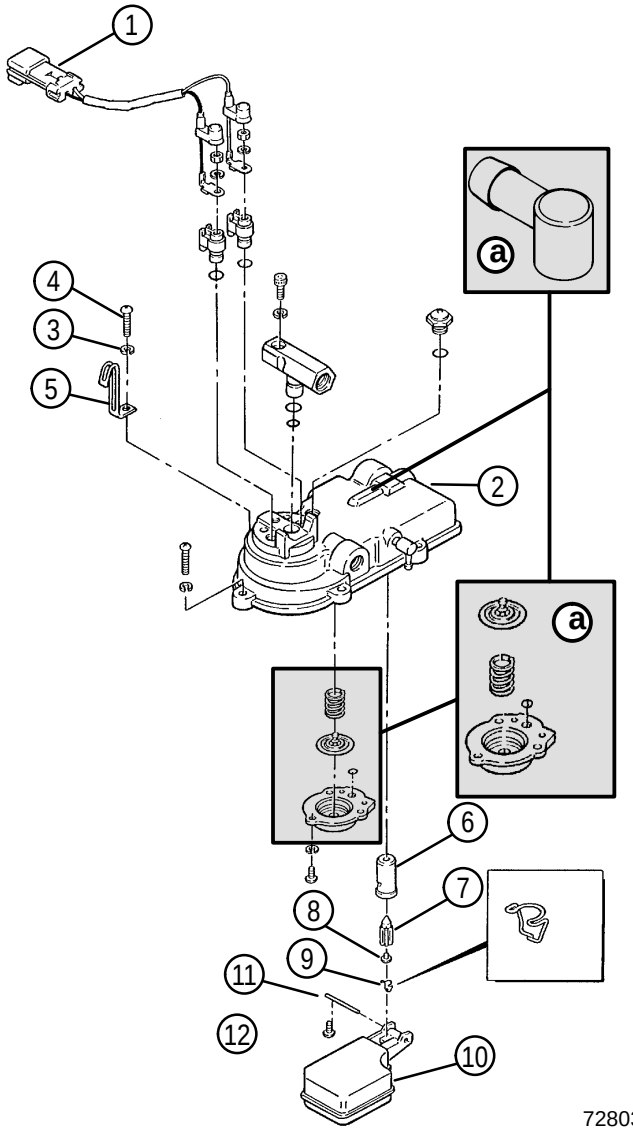
1. Install rubber cushion and plate, making sure to align cutout in plate with pump inlet.
2. Install screen on fuel pump.
3. Install adaptors, collar, plate and new O-ring on fuel pump. Be sure that fuel pump relief valve fits through hole in plate.
4. Slide fuel pump into cover.
5. Apply Loctite Type 8831 to threads of cover screws. Install cover and electrical line retainer clip and tighten cover screws securely.
6. Connect fuel pump electrical connectors. Snap connector covers in place. Secure electrical line in retainer clip.
7. Install L-joint onto cover. Tighten screw securely.
8. Connect all fuel lines to cover of vapor separator tank. Torque fuel line fittings to 23 lb. ft. (31 N·m).
9. Connect fuel pump electrical connector.
10. With engine OFF, cycle ignition switch to ON, wait 2 seconds and then OFF, four times waiting 10 seconds after each key off to prime the fuel system and check for leaks.

NOTE: *If VST is dry, remove the vent screw and fill with fuel.*

Float and Needle Assembly

REMOVAL

1. Disconnect fuel pump electrical connector. (Electric fuel pump removed for visual clarity.)



a - A VST equipped with elbow fitting on top of VST will have this configuration diaphragm and spring.

1 - Electrical Connector
2 - Cover
3 - Lockwashers (6)
4 - Screws (6)
5 - Clip
6 - Valve Seat
7 - Float Valve
8 - Float Valve Pin
9 - Clip
10- Float
11- Float Arm Pin
12- Screw

2. Label and then disconnect all fuel lines from cover of vapor separator tank.
3. Remove electrical line from retaining clip. (some models)
4. Remove cover screws and remove cover and electrical line retainer clip.
5. Remove float arm pin retaining fastener and remove float and needle assembly.
6. Disassemble float and needle assembly; i.e., float valve, float valve pin, clip and float.

CLEANING AND INSPECTION

1. Clean components with carburetor cleaner.

IMPORTANT: Do not soak float or float valve in carburetor cleaner.

2. Inspect float valve seat for wear. Replace if necessary.
3. Inspect float and needle assembly; i.e., float valve, float valve pin, clip and float. Replace parts as necessary.

INSTALLATION

1. Assemble float and needle assembly; i.e., float valve, float valve pin, clip and float.

NOTE: *Float is not adjustable.*

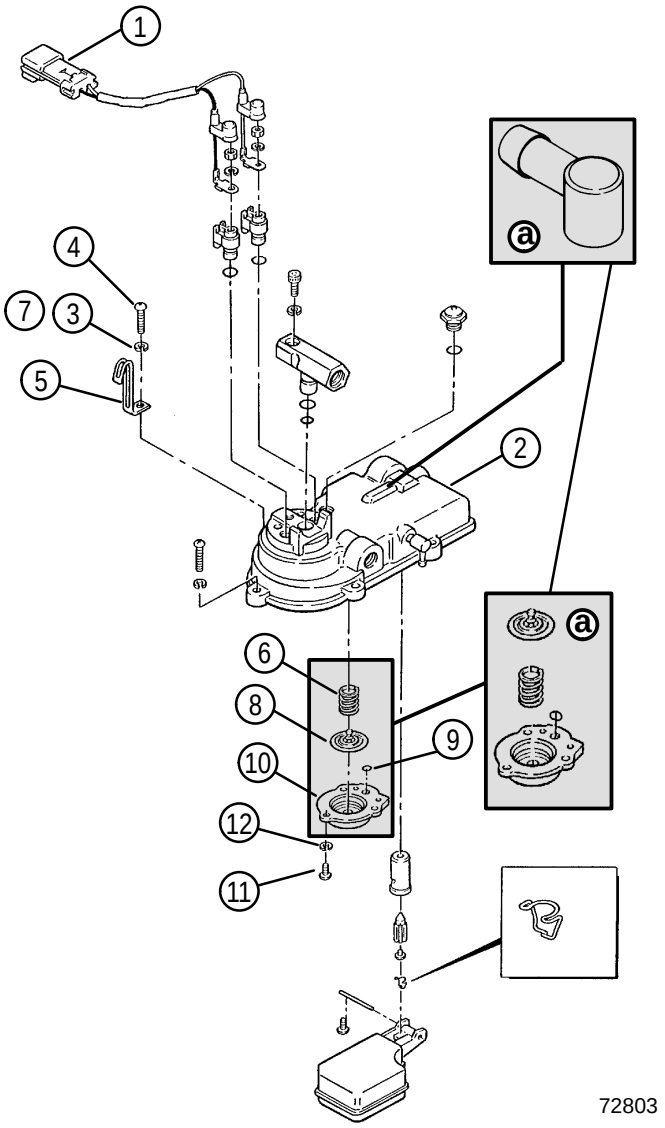
2. Install float and needle assembly and secure float arm pin using fastener.
3. Apply Loctite 8831 to threads of cover screws. Install cover and electrical line retainer clip and tighten cover screws securely.
4. Secure electrical line in retainer clip.
5. Connect all fuel lines to cover of vapor separator tank. Torque fuel line fittings to 23 lb. ft. (31 N·m).
6. Connect fuel pump electrical connector.
7. With engine OFF, cycle ignition switch to ON waiting for 2 seconds, and then OFF, waiting 10 seconds after each key off four times to prime the fuel system and check for leaks.

NOTE: *IF VST is dry. remove vent screw and fill with fuel.*

Diaphragm Assembly

REMOVAL

1. Disconnect fuel pump electrical connector. (Electric fuel pump removed for visual clarity.)



a - A VST equipped with elbow fitting on top of VST will have this configuration diaphragm and spring.

1 - Electrical Connector
2 - Cover
3 - Lockwashers (6)
4 - Screws (6)
5 - Clip
6 - Spring
7 - Diaphragm
8 - O-Ring
9 - Diaphragm Cover
10- O-Ring
11- Screw
12- Lockwasher

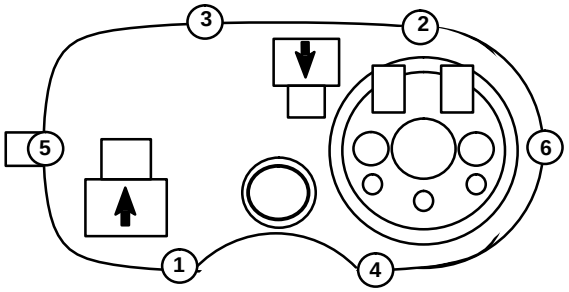
2. Label and then disconnect all fuel lines from cover of vapor separator tank.
3. Remove electrical line from retainer clip.
4. Remove cover screws and remove cover and electrical line retaining clip.
5. Remove float arm pin retaining fastener and remove float and needle assembly.
6. Remove diaphragm cover screws and remove diaphragm cover, O-ring, diaphragm and spring.

CLEANING AND INSPECTION

7. Clean and inspect all parts. Check diaphragm for damage. Replace if necessary.
8. Inspect spring for wear. Replace if necessary.

INSTALLATION

1. Install spring, diaphragm, O-ring and diaphragm cover using diaphragm cover screws. Tighten screws.
2. Install float and needle assembly and secure float arm pin using fastener.
3. Apply Loctite 8831 to threads of cover screws. Install cover and electrical line retainer clip and tighten cover screws securely.



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Torque Sequence For VST

4. Secure electrical line in retainer clip.
5. Connect all fuel lines to cover of vapor separator tank. Torque fuel line fittings to 23 lb. ft. (31 N·m).
6. Connect fuel pump electrical connector.
7. With engine OFF, cycle ignition switch to ON,wait for 2 seconds, then OFF, four times, waiting 10 seconds after each key off to prime the fuel system and check for leaks.

Throttle Body Injection Repair Procedures

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S Coast Guard Rules and Regulations to minimize risks of fire and explosion. Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Special Tools

Description	Part Number
Fuel Pressure Gauge	91-168850A1

Lubricants/Sealants/ Adhesives

Description	Part Number
Loctite 8831	92-823089-1
Loctite 262	Obtain Locally
Loctite 242	

Torque Specifications

Fastener Location	Lb. In.	Lb. Ft.	N•m
Flame Arrestor To Throttle Body		50	6
Throttle Body To Adapter		30	40
Adapter To Intake Manifold			
Intake Manifold To Heads		25	34
VST Cover To Body		6	8
Spark Plugs		11	15
VST To Throttle Body		23	31
Sensors And Plugs To Thermostat Housing	Hand Tight Plus 2-1/2 Turns Maximum		
Knock Sensor		14	19
TP Sensor	20		2
IAC Valve		13	18
Distributor Hold-Down Clamp		30	40
MAP Sensor	53		6

Throttle Body Injection System Description

The fuel system consists of a fuel supply, tank, water separating fuel filter, electric fuel pump, pressure regulator, fuel injectors, throttle body and throttle position (TP) sensor.

Fuel is drawn from the boat's fuel supply tank, through a water separating fuel filter and fuel cooler, by a electrical fuel pump.

A pressure regulator located on the fuel cooler maintains a constant fuel pressure. The fuel bled off from the pressure regulator is delivered back to the water separating fuel filter.

The throttle body is the component of the system which supplies the air required for optimum fuel combustion. The throttle body consists of a housing, two injectors, two throttle plates, throttle plate linkage, idle air control (IAC) valve and throttle position (TP) sensor.

Service Precautions

⚠WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hoses; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hoses.

⚠WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in the area while changing fuel filter(s). Wipe up any spilled fuel immediately.

⚠WARNING

Be sure that the engine compartment is well ventilated and that no gasoline vapors are present to avoid the possibility of fire.

⚠WARNING

Make sure no fuel leaks exist before closing engine hatch.

⚠CAUTION

Fuel pressure MUST BE relieved before servicing any component in the fuel system.

⚠CAUTION

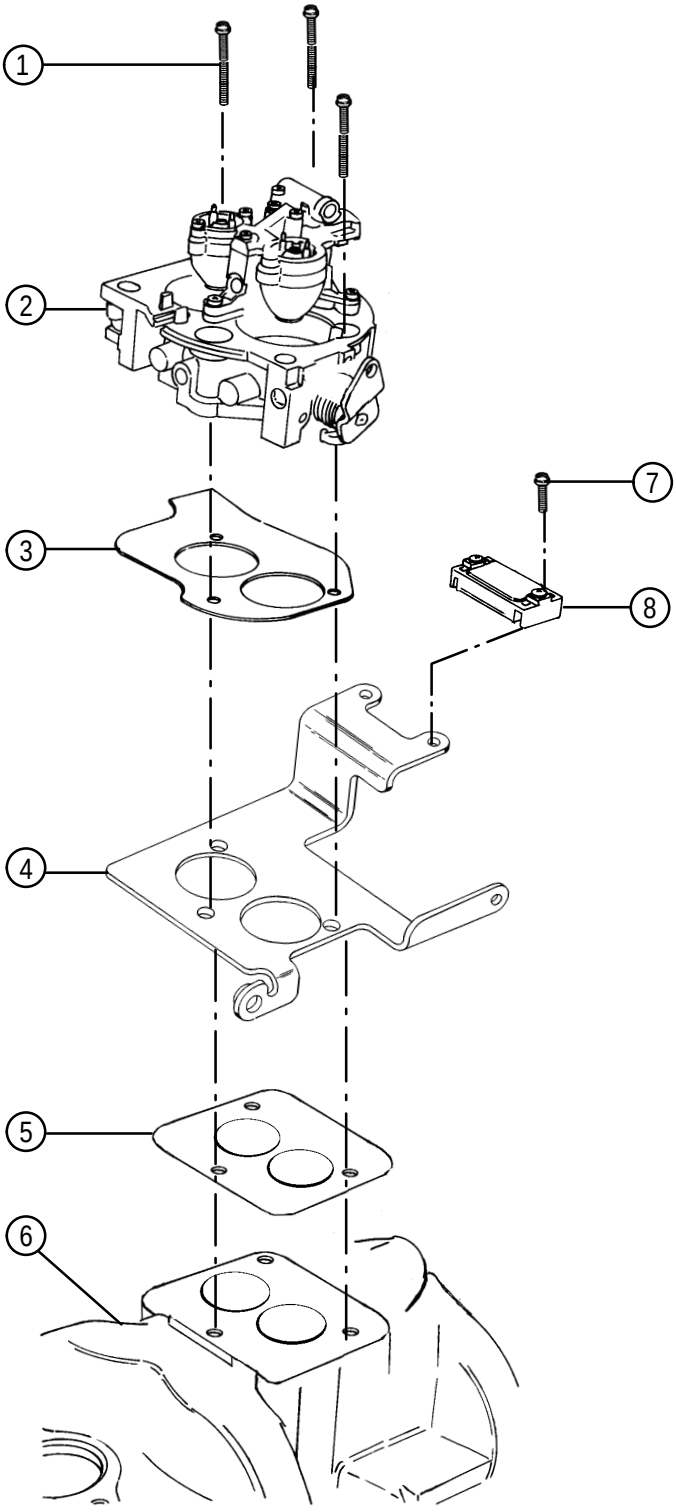
DO NOT operate engine without cooling water being supplied to seawater pump or water pump impeller will be damaged and subsequent overheating damage to engine may result.

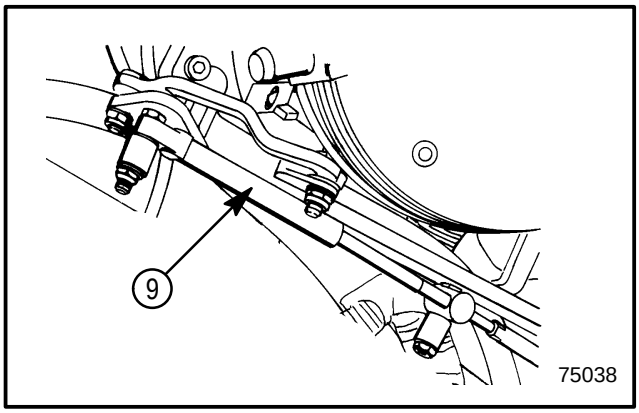
The following information MUST BE adhered to when working on the fuel system:

- **Always keep a dry chemical fire extinguisher at the work area.**
- **Always install new O-rings when assembling fuel system parts.**
- **DO NOT replace fuel pipe with fuel hose.**
- **Always relieve system fuel pressure prior to servicing any component in the fuel system.**
- **DO NOT attempt any repair to the fuel system until instructions and illustrations relating to that repair are thoroughly understood.**
- **Observe all Notes and Cautions.**

Throttle Body Exploded Views

Induction System





1 - Screws (3)
2 - Throttle Body Unit
3 - Gasket
4 - Throttle Body Adapter Plate
5 - Gasket
6 - Intake Manifold
7 - Screws (2)
8 - Manifold Absolute Pressure (MAP) Sensor
9 - Throttle Linkage

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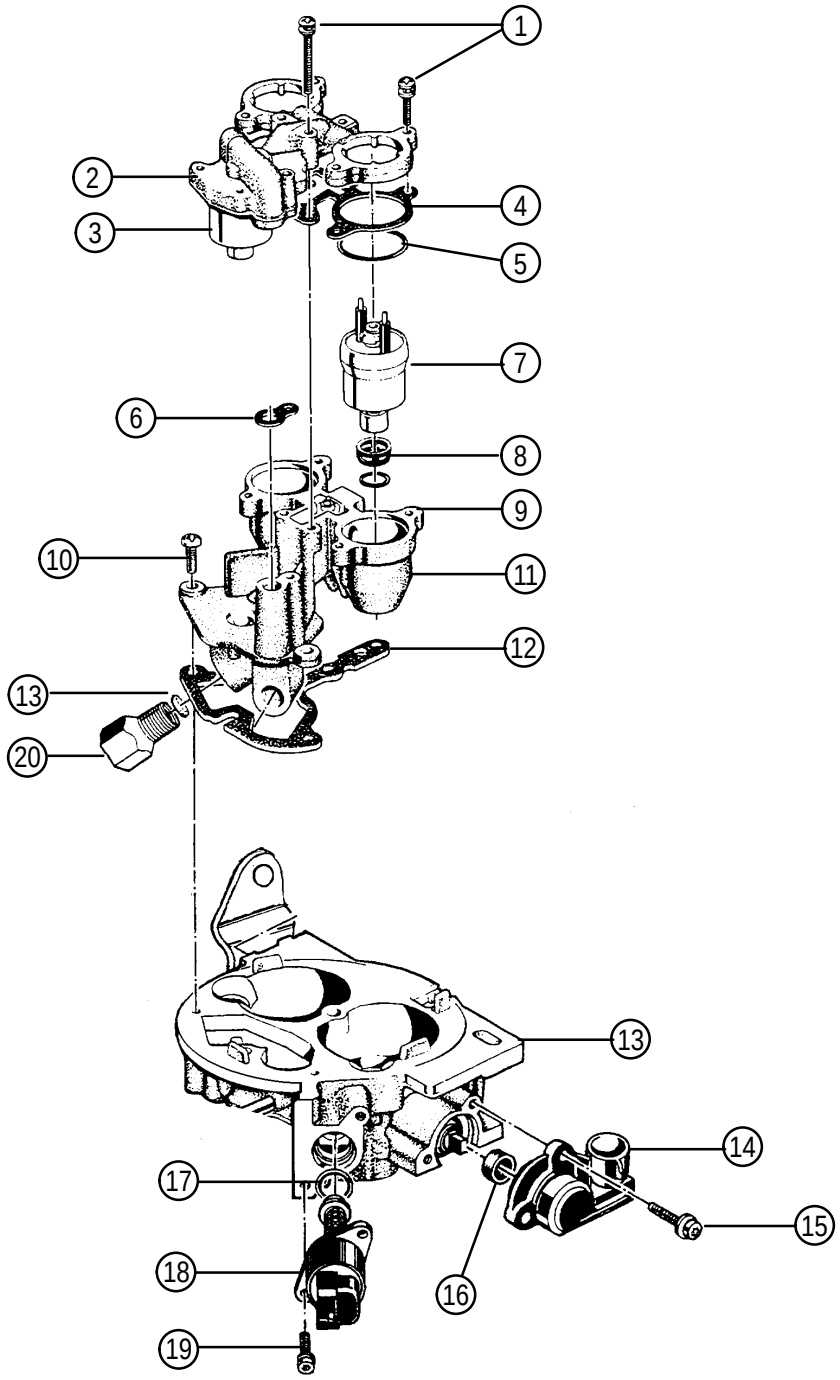
Throttle Body



1 - Cap Screw
2 - Cover Assembly
3 - Fuel Pressure Regulator
4 - Cover Assembly Gasket
5 - Upper O-Ring
6 - Fuel Meter Outlet Gasket
7 - Fuel Injector (2)
8 - Fuel Filter (2)
9 - Lower O-Ring
10- Screw
11- Body
12- Throttle Body To Fuel Meter Body Gasket
13- Throttle Body
14- Throttle Position (TP) Sensor
15- Screws (2)
16- Seal
17- O-Ring
18- Idle Air Control (IAC) Valve
19- Screws (2)
20- Fuel Inlet

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Fuel Pressure Relief Procedure

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

1. Disconnect electrical connector from fuel pump.
2. Crank engine for ten seconds (if engine starts allow it to run until it dies) to relieve any fuel pressure in the system.

Fuel Meter Cover Assembly

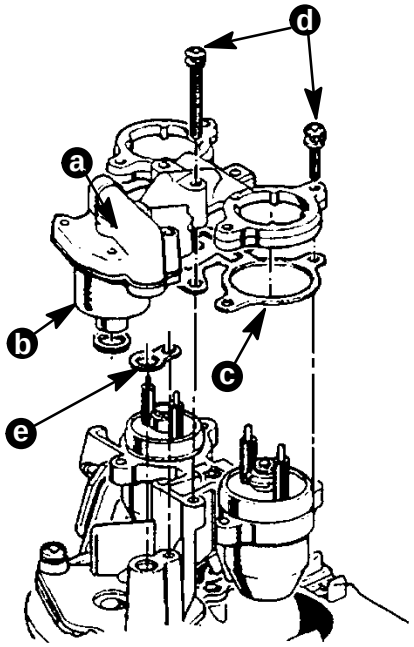
NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

⚠CAUTION

DO NOT remove the four screws securing the pressure regulator to the fuel meter cover. The fuel pressure regulator includes a large spring under heavy compression which, if accidentally released, could cause personal injury.

REMOVAL

1. Remove the flame arrestor from the throttle body.
2. Disconnect electrical connectors to fuel injectors. (Squeeze plastic tabs and pull straight up.)
3. Remove the fuel meter cover screw assemblies.
4. Remove fuel meter cover assembly.



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a - Fuel Meter Cover
b - Fuel Damper
c - Gaskets (Regulator Passages)
d - Screws
e - Fuel Meter Outlet Gasket

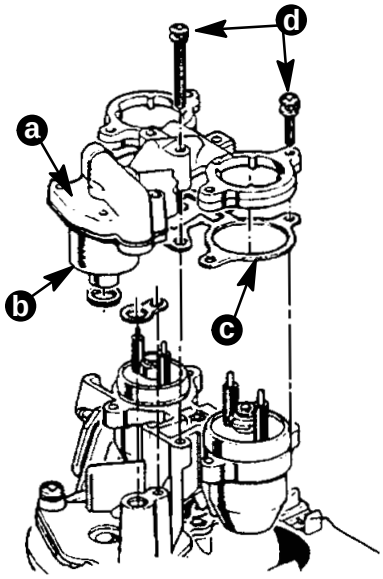
CLEANING AND INSPECTION

IMPORTANT: DO NOT immerse the fuel meter cover (with pressure regulator) in cleaner, as damage to the regulator diaphragm and gasket could occur.

1. Inspect pressure regulator seating area for pitting, nicks, burrs or irregularities. Use a magnifying glass if necessary. If any of the above is present, replace the cover assembly.

INSTALLATION

1. Install new pressure regulator seal, fuel meter outlet passage gasket, and cover gasket.
2. Install fuel meter cover assembly.
3. Install attaching screws, precoated with appropriate locking compound to threads. (Short screws are next to injectors.)
4. Torque screws to 28 lb. in. (3 N·m).
5. Connect electrical connectors to fuel injectors.
6. With engine “OFF,” and ignition “ON,” check for leaks around gasket and fuel line couplings.



73767

a - Fuel Meter Cover
b - Pressure Regulator Assembly
c - Gaskets (Regulator Passages)
d - Screws

Fuel Injectors

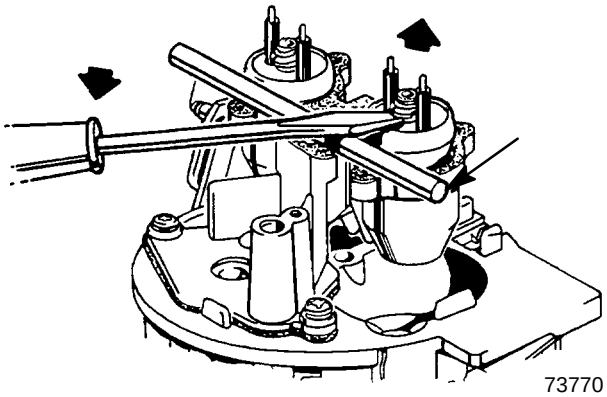
NOTICE
Refer to “Service Precautions,” in “Repair Procedures,” BEFORE proceeding.

REMOVAL

NOTE: *Use care in removing fuel injectors to prevent damage to the electrical connector and nozzle.*

IMPORTANT: The fuel injector is an electrical component. DO NOT soak in any liquid cleaner or solvent, as damage may result.

1. Remove flame arrestor and fuel meter cover as outlined in this section.
2. Using a screwdriver carefully pry up on fuel injector to remove it from the fuel meter body (Use a screwdriver or rod under the the screwdriver when prying up. Leave old gasket in place to prevent damage to fuel meter body).



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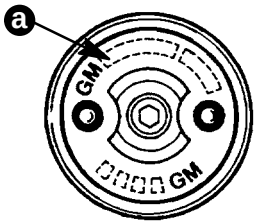
CLEANING AND INSPECTION

Inspect fuel injectors for damage; replace if necessary.

IMPORTANT: When replacing injectors, be certain to replace with the identical part and part number. Other injectors may have the same appearance, yet have a different part number and be calibrated for a different flow rate, and if installed, would cause performance difficulty or damage to the ECM.



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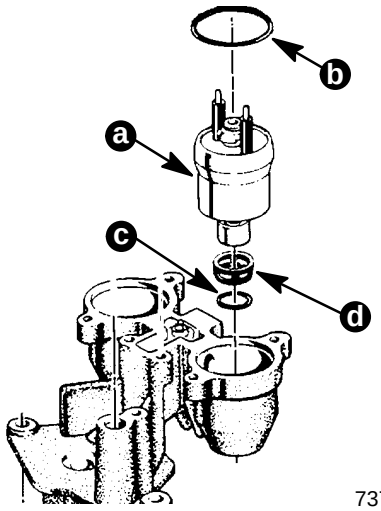
a - Part Indentification Number

INSTALLATION

1. Install new lower O-rings on fuel injectors. Lubricate O-rings using a water soap solution.



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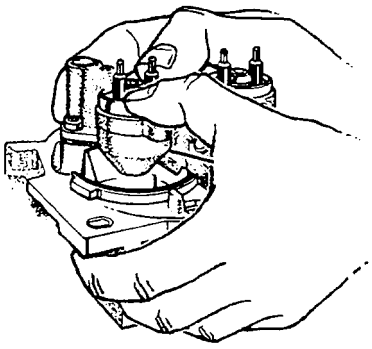
a - Fuel Injector
b - Upper O-Ring
c - Lower O-Ring
d - Fuel Filter

2. Install upper O-rings in fuel meter body. Lubricate O-rings with water soap solution.
3. Install fuel injectors into the fuel meter body. Align the raised lug on the injector base with the notch in fuel meter cavity.



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NOTE: *The electrical terminals of the injectors should be parallel with throttle shaft.*

4. Install gasket and fuel meter cover, torque screws to 28 in. lb. (3.0 N·m) and flame arrestor as outlined in this section.
5. Connect electrical connections to fuel injectors.
6. With engine “OFF,” and ignition “ON,” check for leaks around gasket and fuel line couplings

Throttle Body

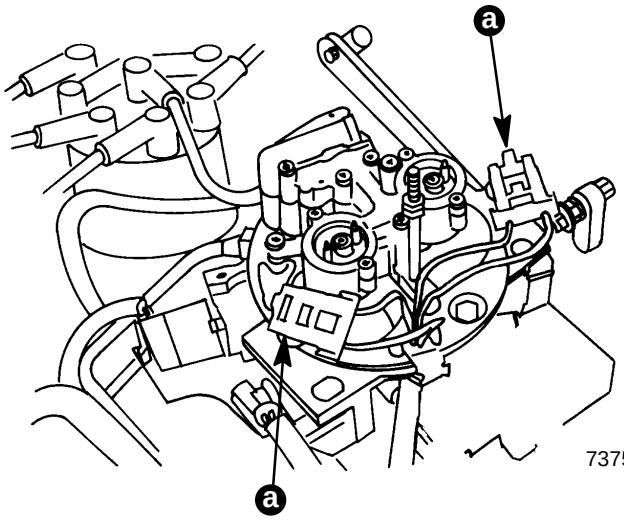
REMOVAL

⚠CAUTION

Ensure that fuel pressure is relieved before removing the fuel inlet and return lines.

IMPORTANT: DO NOT allow the TP sensor, fuel pressure regulator, fuel injectors and IAC valve to come into contact with solvent or cleaner. These components should be removed prior to immersion in solvent.

1. Remove the flame arrestor from the throttle body.
2. Disconnect throttle cable.
3. Disconnect the electrical connections from the TP sensor, IAC and fuel injectors. (Squeeze plastic tabs on injectors and pull straight up).



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a - Electrical Connections

4. Remove fuel inlet and outlet lines from throttle body.
5. Remove screws retaining the throttle body to adapter plate.

NOTE: *Place a shop rag over the intake manifold opening to prevent debris from entering intake manifold.*

CLEANING AND INSPECTION

1. Thoroughly clean metal parts of throttle body in a cold immersion type cleaner. Dry with compressed air. Make certain that all passages are free of dirt and burrs.
2. Inspect mating surfaces for damage that could affect gasket sealing.
3. Inspect throttle body for cracks in casting.
4. Inspect throttle plates, linkage, return springs, etc., for damage, wear and foreign material.
5. Check intake manifold plenum for loose parts and foreign material.

INSTALLATION

1. Install fuel injectors and fuel meter body as previously described in this section.
2. Install a new gasket on adapter plate.
3. Install throttle body on adapter plate and torque the screws. 30 ft. lb. (40 N·m).
4. Connect throttle linkage to throttle body.
5. Move throttle from idle to WOT and check that the throttle movement is not binding.
6. Connect the fuel inlet and return lines. Torque to 23 ft. lb. (31 N·m).
7. Connect TP sensor, IAC, and fuel injectors connections.
8. Turn key to on position and check for fuel leaks around the inlet and return line connections.
9. Start engine and check for fuel leaks.

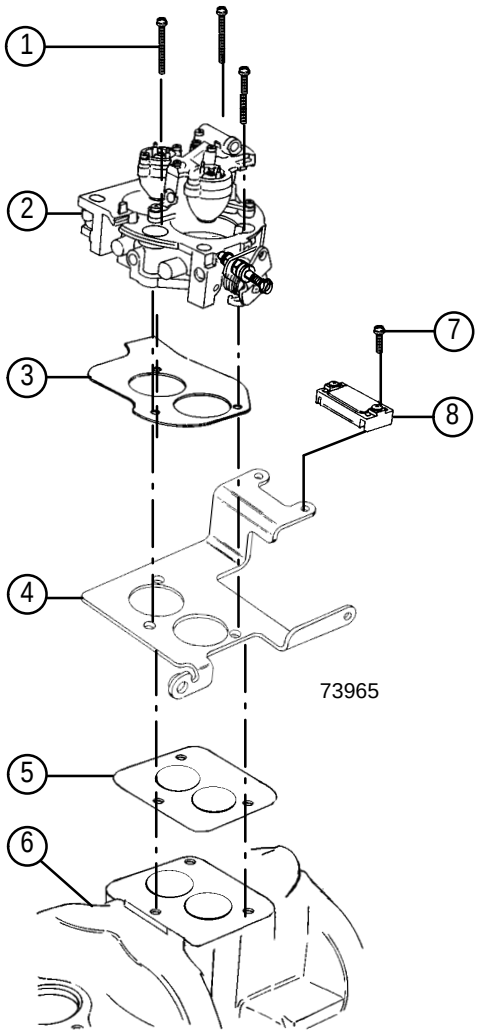
Throttle Body Adapter Plate

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

IMPORTANT: Place a clean shop towel over the intake manifold opening to prevent foreign material from entering the engine.

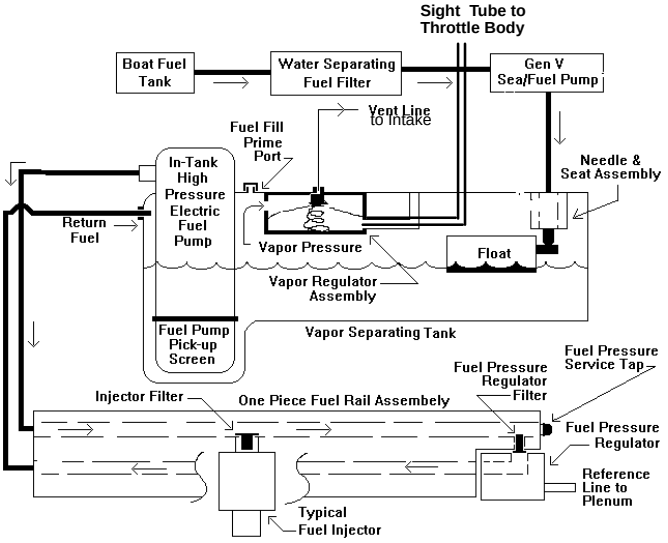
1. Remove flame arrestor.
2. Remove throttle body refer to Throttle Body Section.
3. Remove screws and the throttle body adapter from the intake manifold.



1 - Screws (3)
2 - Throttle Body Unit
3 - Gasket
4 - Throttle Body Adapter Plate
5 - Gasket
6 - Intake Manifold
7 - Screws (2)
8 - Manifold Absolute Pressure (MAP) Sensor

Multi-Port System Description

The MerCruiser EFI Fuel System consists of a fuel supply, water separating fuel filter, mechanical fuel pump, vapor separator tank (VST), electric fuel pump, injector fuel filter, fuel rail, pressure regulator, fuel injectors, throttle body and throttle position (TP) sensor.



Fuel is drawn from the boat's fuel supply (tank), through a water separating fuel filter, by a mechanical fuel pump mounted on and driven by a seawater pump, and is delivered to the vapor separator tank (VST).

The VST consists of a reservoir, float, needle and seat assembly, fuel pump pickup screen, electric fuel pump. The electric fuel pump located in the VST, pumps the fuel rail supplying pressurized fuel to the fuel injectors.

A pressure regulator located on the fuel rail maintains a constant fuel pressure in the fuel rail. The fuel bled off from the pressure regulator is delivered back to the VST.

The throttle body is the component of the system which supplies the air required for optimum fuel combustion. The throttle body consists of a housing, two throttle plates, throttle plate linkage, idle air control (IAC) valve and throttle position (TP) sensor.

Service Precautions

⚠WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in the area while changing fuel filter(s). Wipe up any spilled fuel immediately.

⚠WARNING

Be sure that the engine compartment is well ventilated and that no gasoline vapors are present to avoid the possibility of fire.

⚠WARNING

Make sure no fuel leaks exist, before closing engine hatch.

⚠CAUTION

Fuel pressure MUST BE relieved before servicing high pressure component in the fuel system.

⚠CAUTION

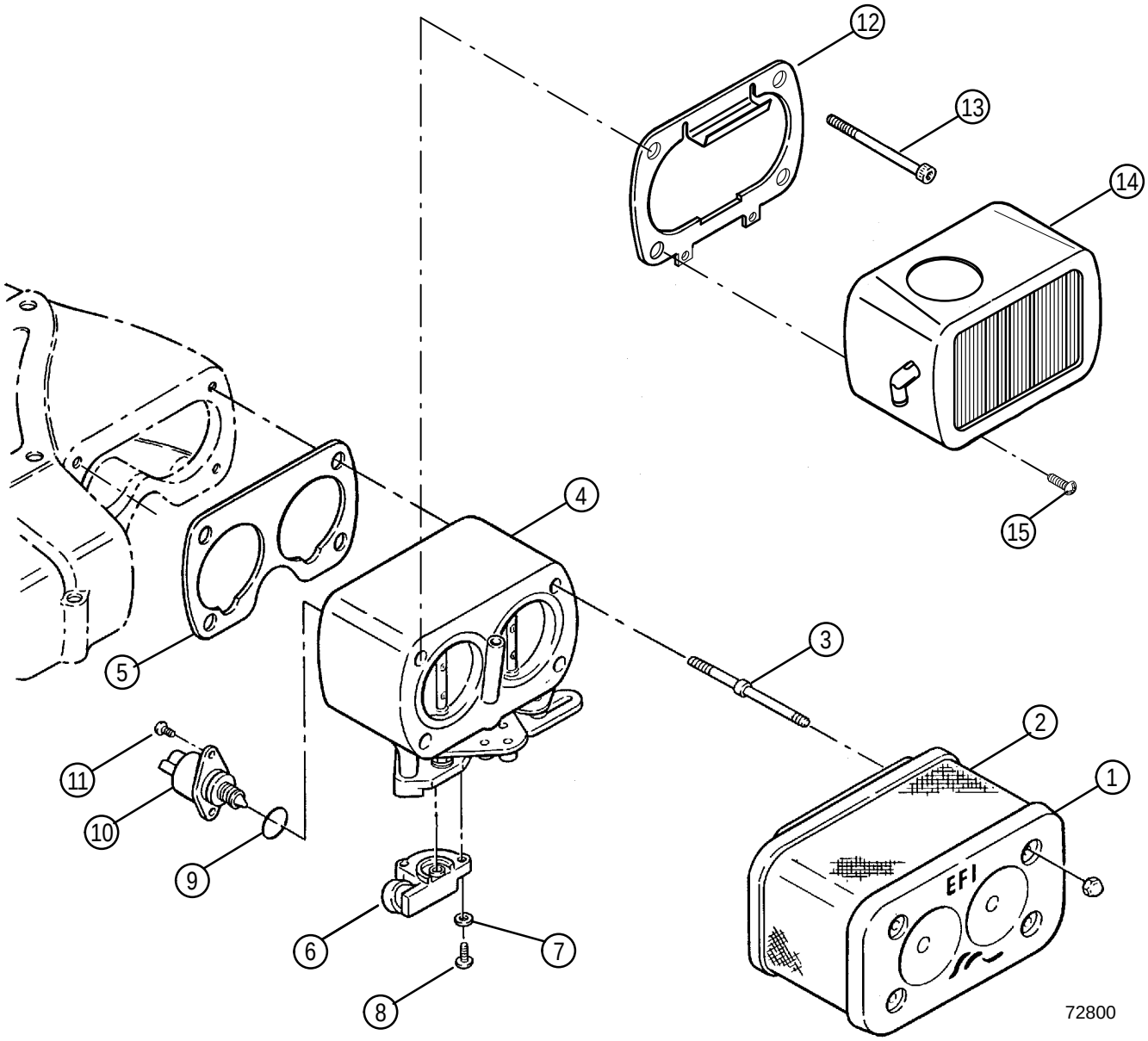
DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

The following information MUST BE adhered to when working on the fuel system:

- **Always keep a dry chemical fire extinguisher at the work area.**
- **Always install new O-rings when assembling fuel pipe fittings.**
- **DO NOT replace fuel pipe with fuel hose.**
- **DO NOT attempt any repair to the fuel system until instructions and illustrations relating to that repair are thoroughly understood.**
- **Observe all Notes and Cautions.**

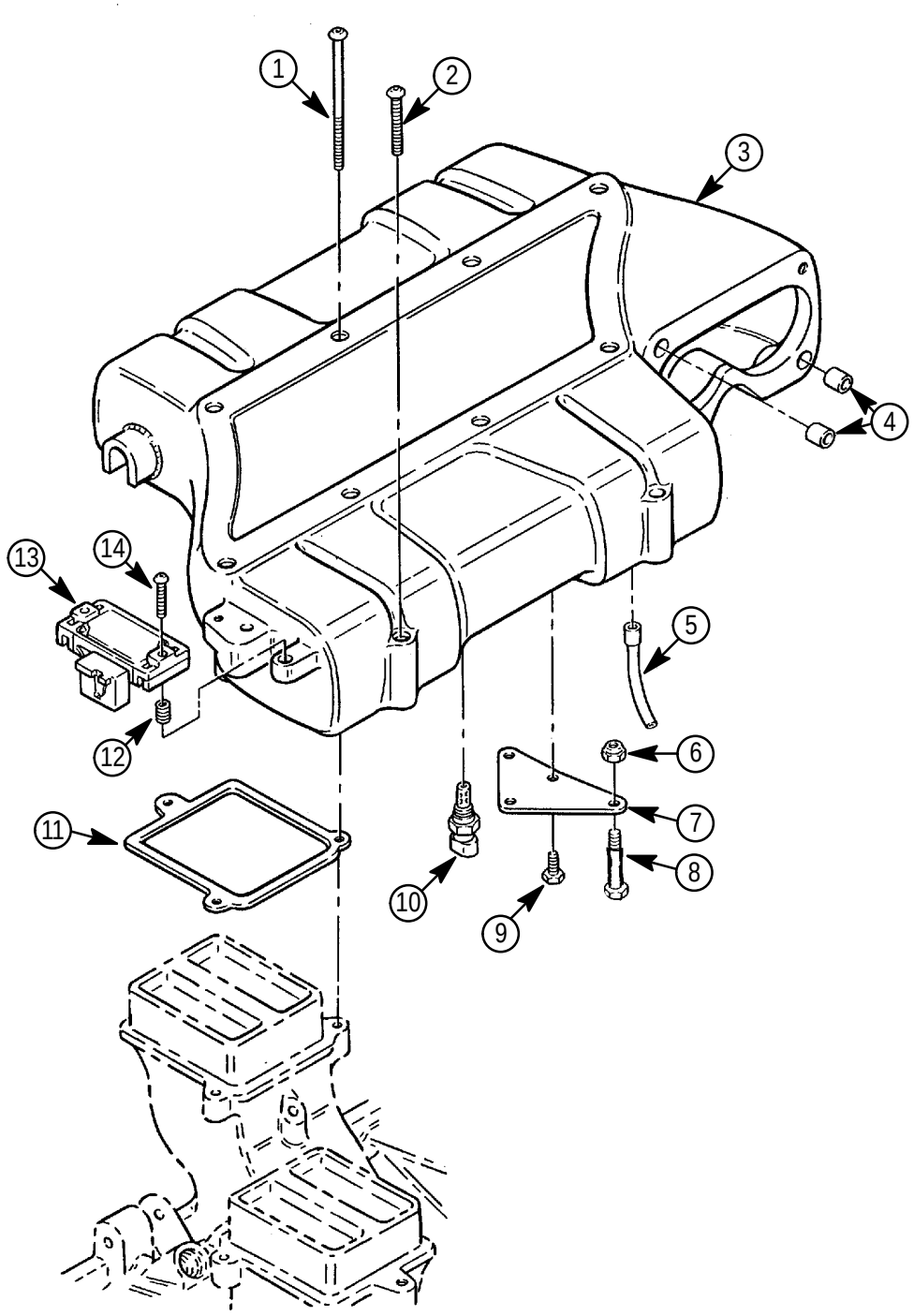
Multi-Port Exploded Views

Flame Arrestor and Throttle Body



1 - Cap Nut
2 - Flame Arrestor
3 - Stud
4 - Throttle Body
5 - Gasket
6 - Throttle Position (TP) Sensor
7 - Washer
8 - Screw
9 - O-Ring
10- Idle Air Control (IAC) Valve
11- Screw
12- Mounting Bracket (1997 and Newer Models)
13- Screw (1997 and Newer Models)
14- Flame Arrestor (1997 and Newer Models)
15- Screw (1997 and Newer Models)

Plenum



72802

1 - Screw
2 - Screw
3 - Plenum
4 - Sleeve
5 - Drain Line To Intake
6 - Nut
7 - Bracket
8 - Stud
9 - Screw
10- Intake Air Temperature (IAT) Sensor
11- Gasket
12- Seal
13- Manifold Absolute Pressure (MAP) Sensor
14- Screw

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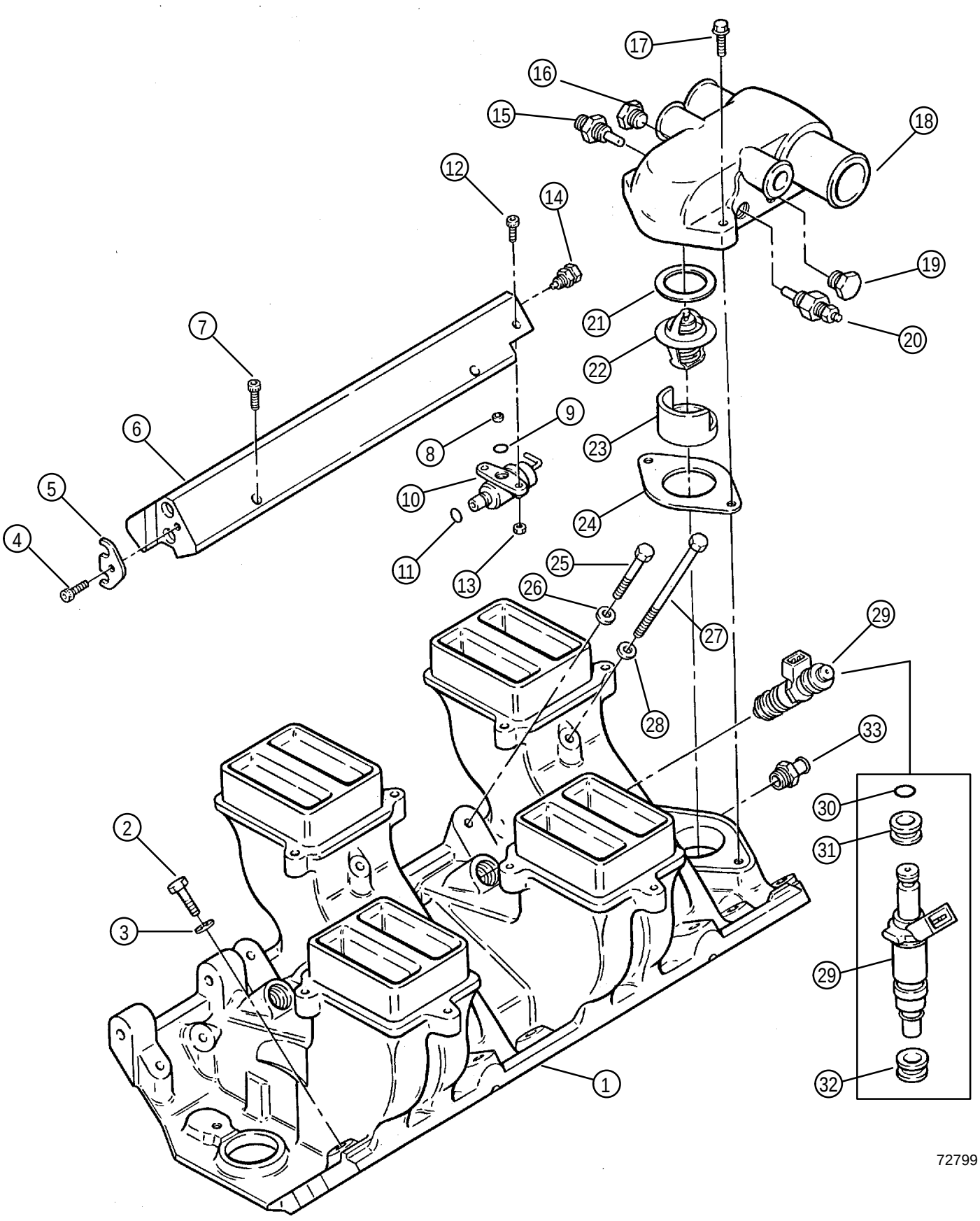
Intake Manifold and Fuel Rail



Index

1 -Intake Manifold
2 -Bolt
3 -Washer
4 -Bolt
5 -Retainer
6 -Fuel Rail
7 -Bolt
8 -Filter
9 -O-Ring
10-Pressure Regulator (VST Models) Or Fuel Damper (Cool Fuel Models)
11-O-Ring
12-Screw
13-Nut
14-Schrader Valve
15-Engine Coolant Temperature (ECT) Sensor
16-Plug
17-Bolt
18-Thermostat Housing
19-Plug
20-Water Temperature Sender
21-Gasket
22-Thermostat
23-Sleeve
24-Gasket
25-Bolt
26-Washer
27-Bolt
28-Washer
29-Fuel Injector
30-O-Ring
31-Grommet
32-Grommet
33-Fitting

Fuel Pressure Relief Procedure

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

1. Disconnect electrical connector at fuel pump.
2. Crank engine for ten seconds (if engine starts allow it run until it dies) to relieve any fuel pressure in the system.

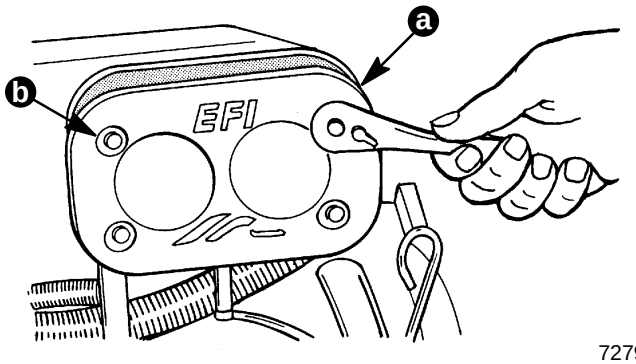
Multi-Port Components

Flame Arrestor

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

Remove four flame arrestor mounting cap nuts and remove flame arrestor from throttle body.



72790

a - Flame Arrestor
b - Cap Nuts (4)

CLEANING AND INSPECTION

Clean flame arrestor in solvent and dry with compressed air.

INSTALLATION

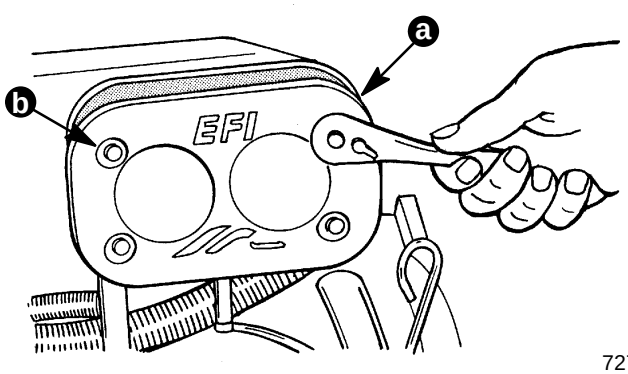
1. Install flame arrestor to throttle body.
2. Apply Loctite 242 to threads of studs. Install four flame arrestor mounting cap nuts. Torque cap nuts to 50 lb. in. (6 N·m).

Throttle Body

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

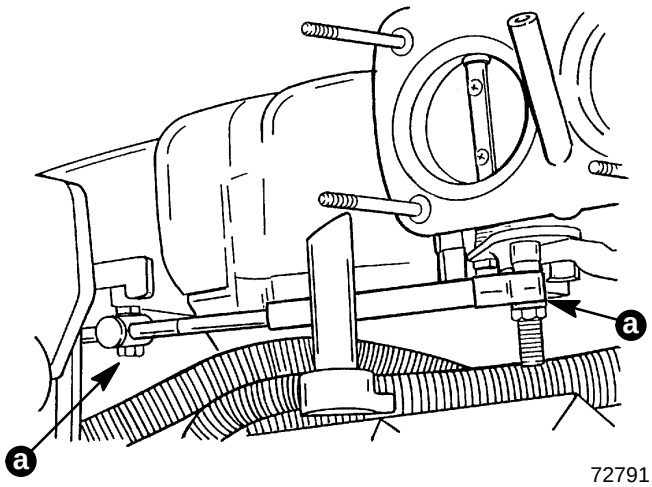
1. Remove four flame arrestor mounting cap nuts and remove flame arrestor from throttle body.



72790

a - Flame Arrestor
b - Cap Nuts (4)

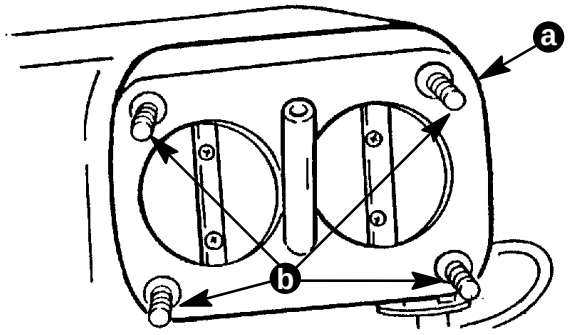
2. Disconnect throttle linkage.



72791

a - Throttle Linkage Connections

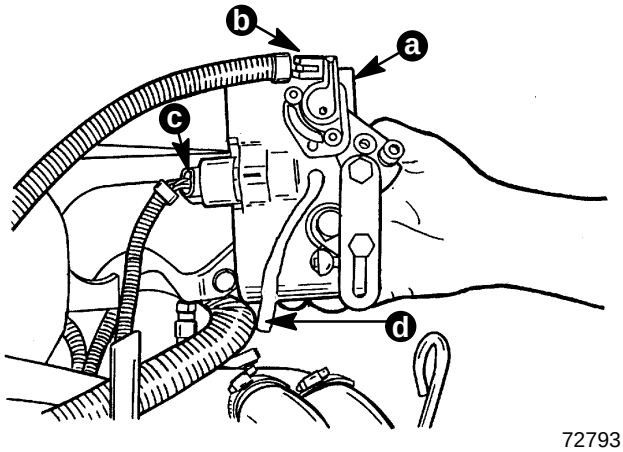
3. Remove four throttle body mounting studs using a stud driver.



72792

a - Throttle Body
b - Throttle Body Mounting Studs

4. Turn throttle body as shown and disconnect TP, drain tube and IAC electrical connectors.



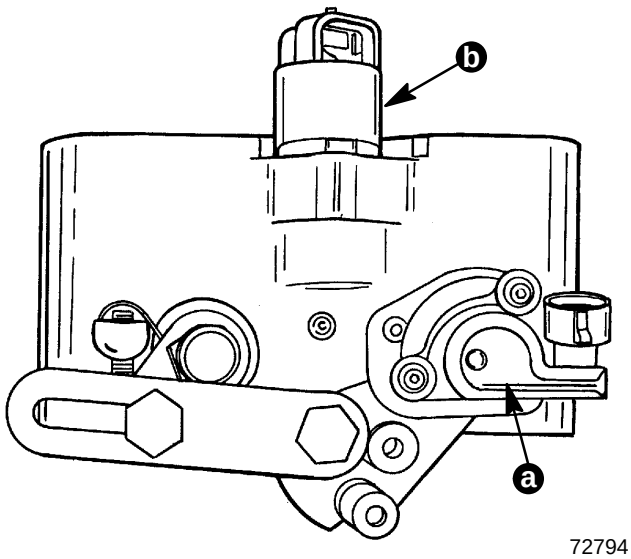
72793

a - Throttle Body
b - Throttle Position (TP) Sensor
c - Idle Air Control (IAC) Valve
d - Drain Tube

IMPORTANT: To prevent damage to throttle valve, it is essential that throttle body be placed on a holding fixture before performing service.

IMPORTANT: Insert a clean shop towel into the opening of the plenum to prevent foreign material from entering the engine.

5. Remove TP with O-ring and IAC valve with O-ring from throttle body.



72794

a - Throttle Position (TP) Sensor
b - Idle Air Control (IAC) valve

CLEANING AND INSPECTION

IMPORTANT: DO NOT use cleaners containing methyl ethyl ketone. It is not necessary for cleaning throttle bore and valve deposits.

IMPORTANT: DO NOT allow the TP and IAC valve to come into contact with solvent or cleaner.

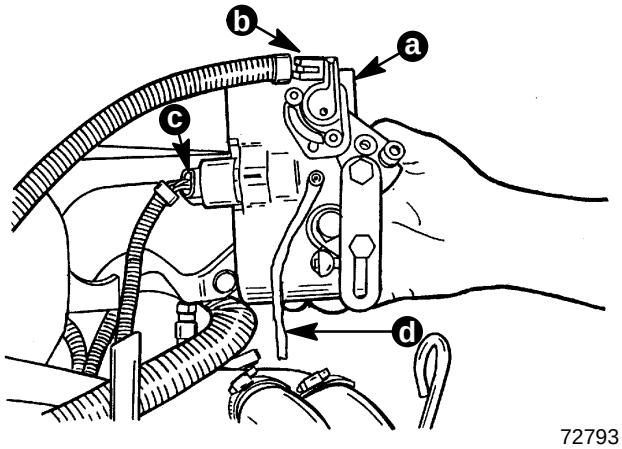
IMPORTANT: Use care when removing gasket material from plenum and throttle body. Failure to do so could result in damage to the plenum and throttle body.

1. Carefully remove all gasket material from plenum and throttle body.
2. Thoroughly clean all parts of throttle body. Make certain that all passages are free of dirt and burrs.
3. Inspect mating surfaces for damage that could affect gasket sealing.
4. Inspect throttle body for cracks in casting.
5. Inspect throttle plates, linkage, return springs, etc., for damage, wear and foreign material.
6. Check plenum for loose parts and foreign material.

INSTALLATION

NOTE: *To prevent difficult removal of fasteners and damage to fastener heads, do not use a higher strength thread locking compound than recommended.*

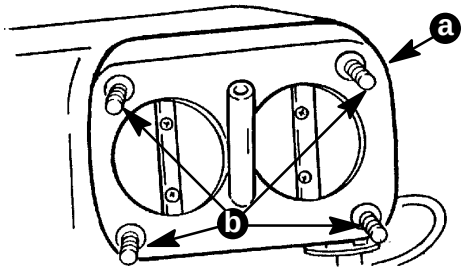
7. Connect TP and IAC electrical connectors, then install throttle body with new gasket using four throttle body mounting studs.



72793

a - Throttle Body
b - Throttle Position (TP) Sensor
c - Idle Air Control (IAC) Valve
d - Sight Tube

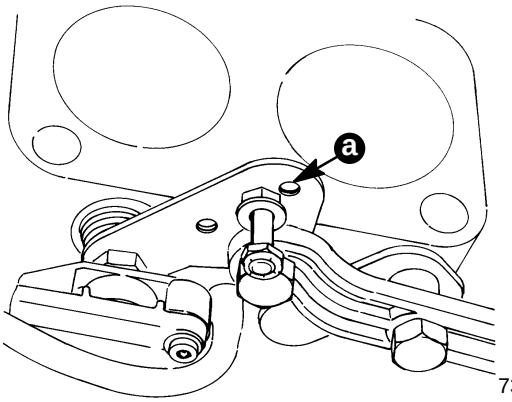
8. Apply Loctite 242 to threads of studs. Using a stud driver, torque studs to 165 lb. in. (18.6 N·m).



72792

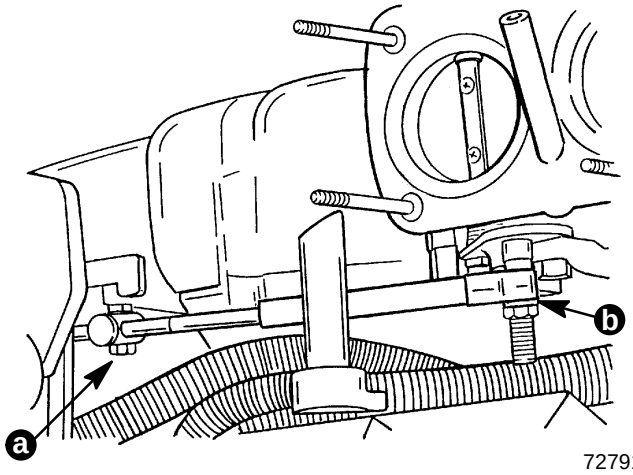
a - Throttle Body
b - Throttle Body Mounting Studs

NOTE: *If Boat is equipped with Quicksilver Zero Effort Controls, the throttle cable mounting stud must be most forward position on throttle lever.*



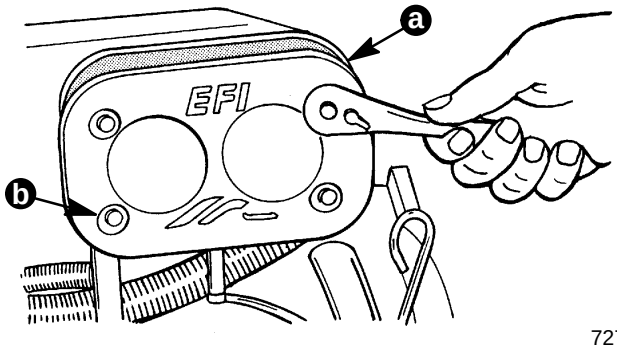
a - Position For Zero Effort Controls

9. Connect throttle linkage. Secure cable barrel anchor stud with locknut and tighten securely. Secure cable end guide to lever stud. Thread locknut on stud until it contacts end guide.



a - Cable Barrel Anchor Stud
b - Locknut

10. Install flame arrestor to throttle body. Apply Loctite 242 to threads of studs. Install four flame arrestor mounting cap nuts. Torque cap nuts to 50 lb. in. (6 N·m).



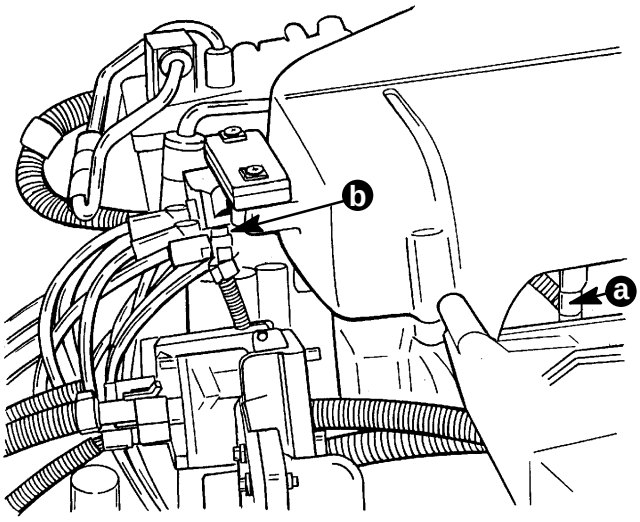
a - Flame Arrestor
b - Cap Nuts (4)

Plenum

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

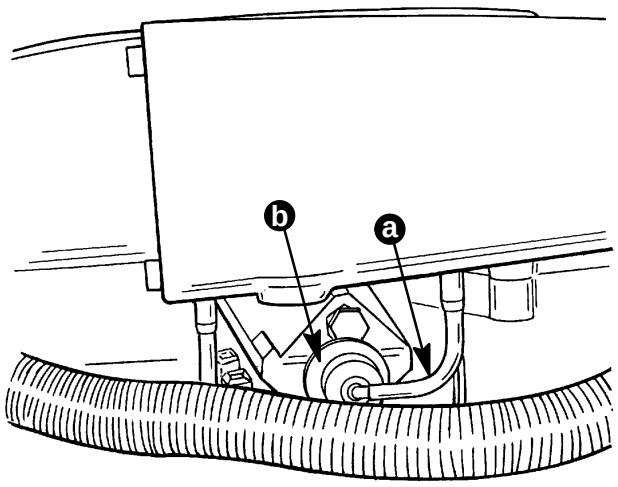
1. Remove flame arrestor and throttle body as outlined previously.
2. Disconnect IAT and MAP sensor electrical connectors



.

a - Intake Air Temperature (IAT) Sensor
b - Manifold Absolute Pressure (MAP) Sensor

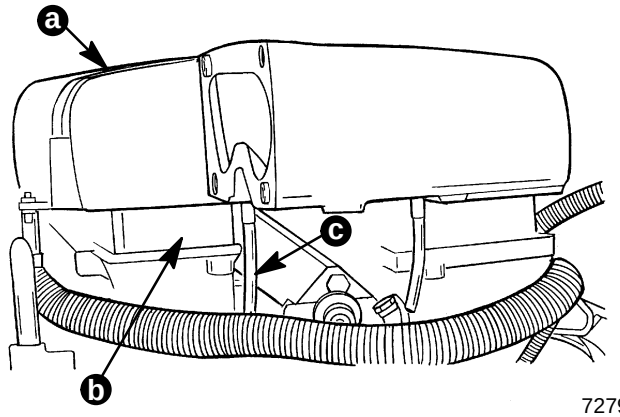
3. Disconnect reference line at pressure regulator.



72796

a - Reference Line
b - Pressure Regulator

4. Remove twelve plenum mounting fasteners and lift straight up from intake manifold. Turn plenum slightly and rest on intake manifold as shown. Disconnect drain line at plenum and remove plenum.



72797

a - Plenum
b - Intake Manifold
c - Drain Line

IMPORTANT: Place a clean shop towel over each of the eight intake manifold openings to prevent foreign material from entering the engine.

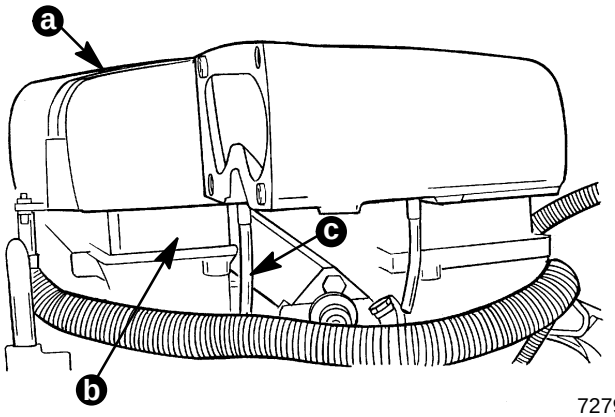
CLEANING AND INSPECTION

IMPORTANT: Use care when removing gasket material from intake manifold and plenum. Failure to do so could result in damage to the intake manifold and plenum.

1. Carefully remove all gasket material from intake manifold and plenum.
2. Clean plenum in solvent and dry with compressed air.
3. Inspect mating surfaces for damage that could affect gasket sealing.
4. Inspect plenum for cracks in casting.

INSTALLATION

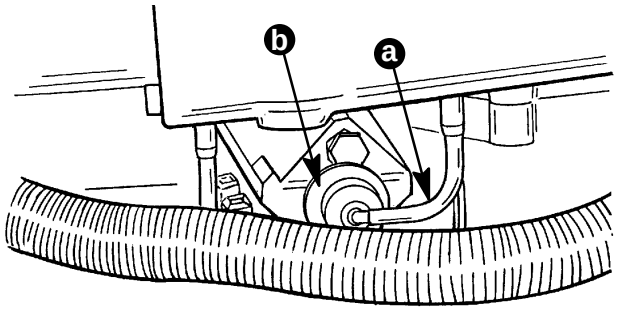
1. Install one gasket onto each of the four intake manifold trumpets.
2. Rest plenum on intake manifold as shown. Connect drain line at plenum. Lower plenum evenly onto intake manifold and install twelve plenum mounting fasteners. Torque fasteners to 150 lb. in. (17 N·m).



72797

a - Plenum
b - Intake Manifold
c - Drain Line

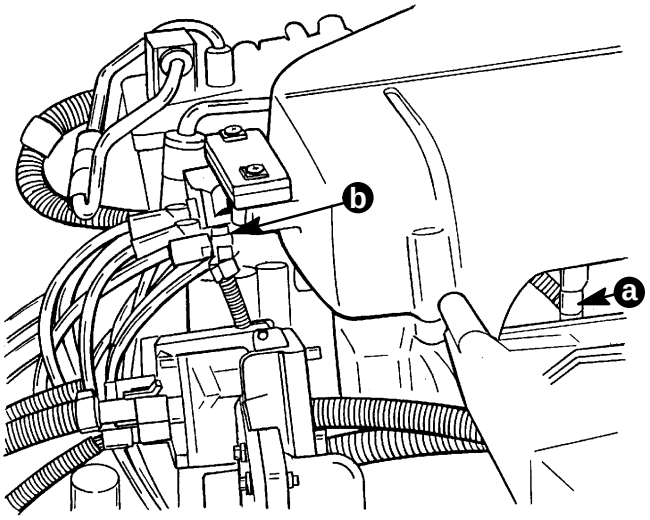
3. Connect reference line to pressure regulator.



72796

a - Reference Line
b - Pressure Regulator (VST Models) Or Fuel Damper (Cool Fuel Models)

4. Connect IAT and MAP sensor electrical connectors.



72795

a - Intake Air Temperature (IAT) Sensor
b - Manifold Absolute Pressure (MAP) Sensor

5. Install throttle body and flame arrestor as outlined previously.

Intake Manifold

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

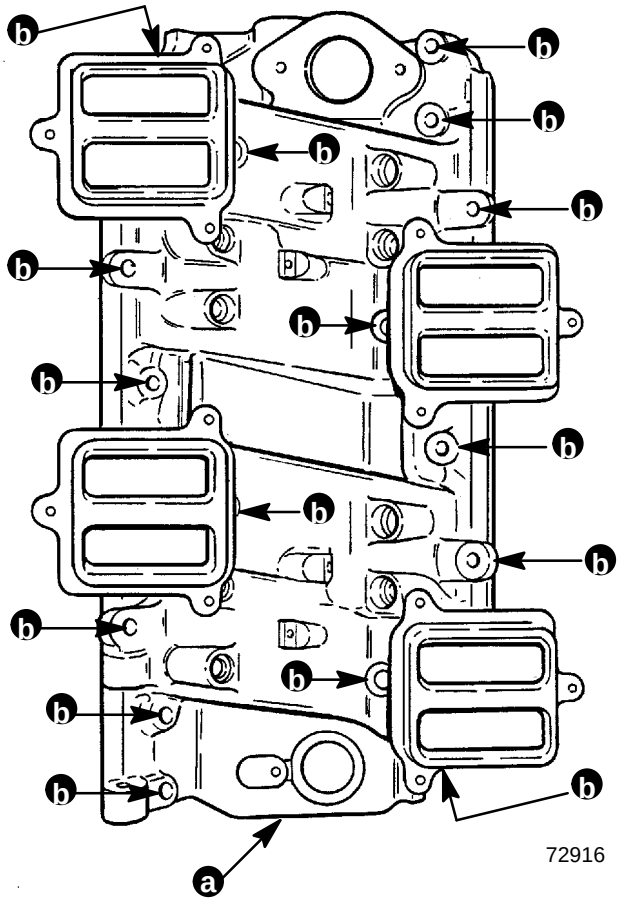
1. Drain engine cooling system. Refer to Section 6A, "Seawater Cooled Models."
2. Remove flame arrestor, throttle body and plenum as outlined previously.
3. Disconnect hoses from thermostat housing.
4. Disconnect intake manifold to circulating pump by-pass hose from circulating pump.
5. Disconnect all electrical leads necessary for intake manifold removal, including fuel injector and distributor connections. Carefully move wiring away from intake manifold.
6. Disconnect crankcase ventilation hoses from rocker arm covers.
7. Remove distributor cap.
8. Scribe a line on the distributor housing marking rotor position. Also, mark position of distributor housing on intake manifold.
9. Remove distributor housing hold-down bolt and clamp.
10. Remove distributor from intake manifold.

IMPORTANT: DO NOT crank engine over after distributor has been removed.

11. Disconnect inlet fuel line at vapor separator tank (VST) and mechanical fuel pump and remove inlet fuel line.
12. Disconnect all miscellaneous items that will prevent removal of manifold.

IMPORTANT: It may be necessary to pry intake manifold away from cylinder heads and block in next step. Use extreme care to prevent damage to sealing surfaces.

13. Remove intake manifold bolts, then remove intake manifold along with VST, fuel rail and injectors.



72916

a - Intake Manifold
b - Bolt Locations

NOTE: *If intake manifold requires replacement, transfer all remaining parts to new manifold.*

Index

CLEANING AND INSPECTION

1. Clean gasket material from all mating surfaces.

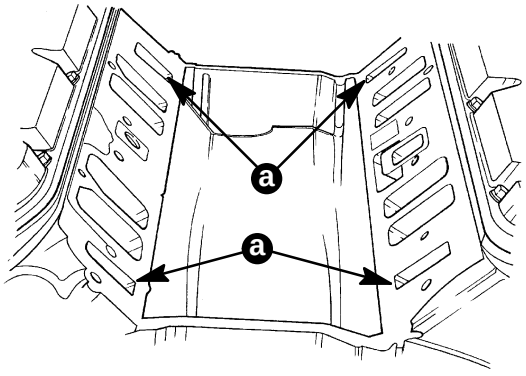
IMPORTANT: When cleaning cylinder head mating surface, DO NOT allow gasket material to enter engine crankcase or intake ports.

2. Clean excessive scale and deposits from the water passages.
3. Inspect manifold for cracks or scratches. Machined surfaces must be clean and free of all marks or deep scratches or leaks may result.
4. Inspect intake passages for varnish buildup or other foreign material. Clean as necessary.

INSTALLATION

IMPORTANT: When installing intake manifold gaskets in the next step, be sure to install gasket with marked side up. Also, both gaskets are NOT identical. Install gaskets on their respective sides of the engine. DO NOT use ANY other gasket than that which is recommended.

1. Apply Quicksilver Perfect Seal to both sides of intake manifold gasket around coolant passages.



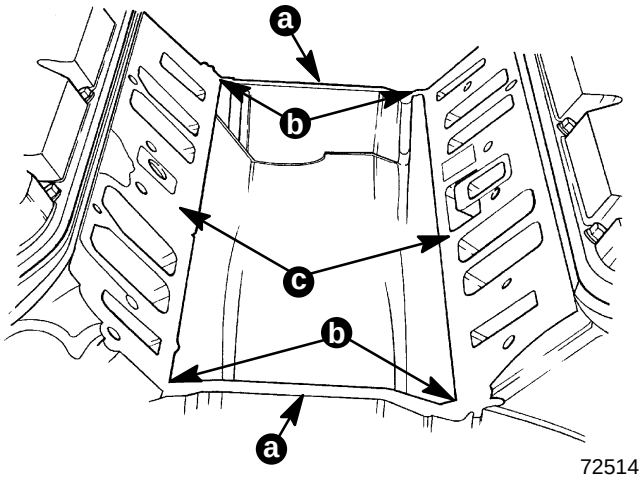
72514

a - Coolant Passages

⚠ WARNING

Be sure to read and follow package label directions when using bellows adhesive.

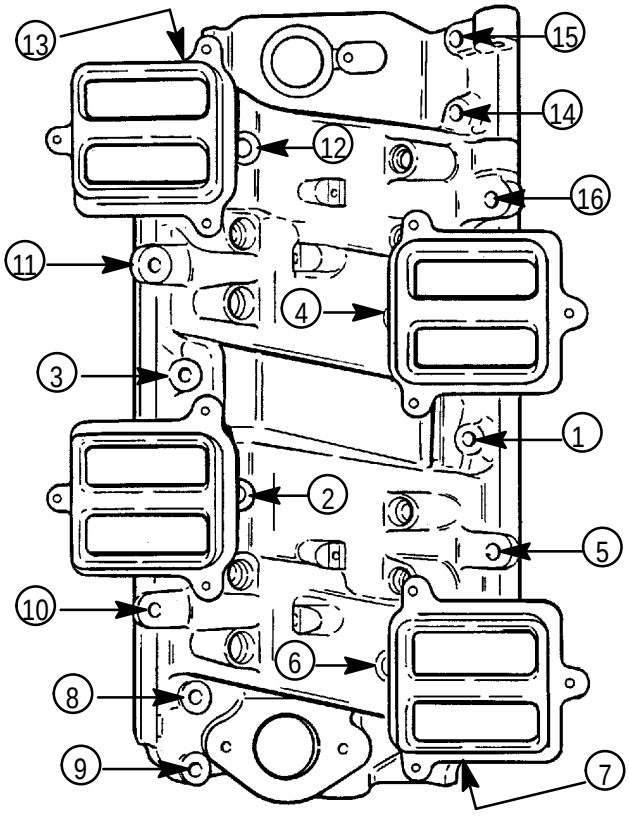
2. Using Quicksilver Bellows Adhesive, glue neoprene gaskets to engine block between cylinder heads.
3. Apply a small amount of RTV Sealer on neoprene gasket ends.



72514

a - Neoprene Gaskets
b - RTV Sealer
c - Gaskets

4. Set intake manifold gaskets in place, aligning bolt holes.
5. Carefully install intake manifold assembly and torque bolts to 25 lb. ft. (34 N·m) in the sequence shown.



72916

Intake Manifold Torque Sequence

6. Connect all miscellaneous items which were disconnected from manifold during removal.
7. Connect inlet fuel line at vapor separator tank (VST) and mechanical fuel pump.
8. Align rotor, housing and intake manifold using scribe marks.
9. Slowly lower distributor through intake manifold and into position. If distributor shaft won't drop into position, back it out and insert a screwdriver into the hole to turn the oil pump drive shaft. Repeat this adjustment as many times as needed until the distributor can be firmly seated and all components are in alignment.
10. Install hold-down clamp over distributor and bolt it securely to engine surface. Torque bolt to 30 lb. ft. (40 N·m).
11. Install distributor cap and secure in place with two screws.
12. Connect crankcase ventilation hoses to rocker arm covers.
13. Install all electrical leads, including fuel injector and distributor connections. (Refer to wiring diagrams.)
14. Connect intake manifold to circulating pump bypass hose.
15. Connect hoses to thermostat housing.
16. Install plenum, throttle body and flame arrestor as outlined previously.

IMPORTANT: Before proceeding to the following step, be certain that engine will obtain an adequate supply of water for cooling. Refer to Section 6A, "Seawater Cooled Models."

17. Start engine. Adjust ignition timing and check hose connections, gaskets and seals for leaks.
18. Inspect fuel line connections for fuel leaks.

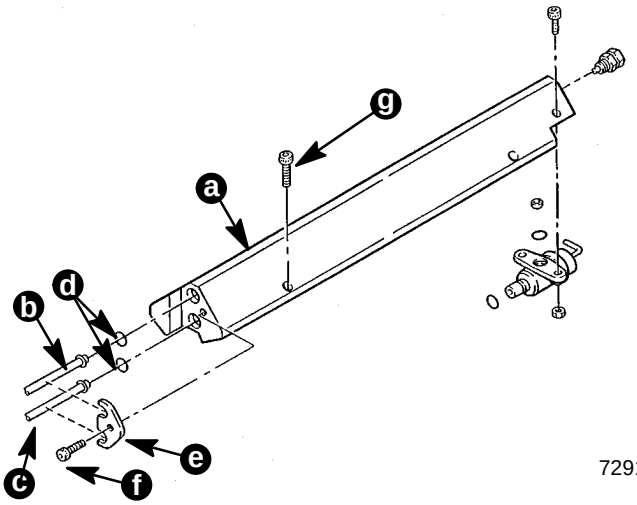
Fuel Rail and Injectors

Fuel Rail

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Remove flame arrestor, throttle body, and plenum as outlined in this section.
2. Disconnect electrical connector at each fuel injector.
3. Remove fuel line retainer from fuel rail. Remove inlet and outlet fuel lines from fuel rail.



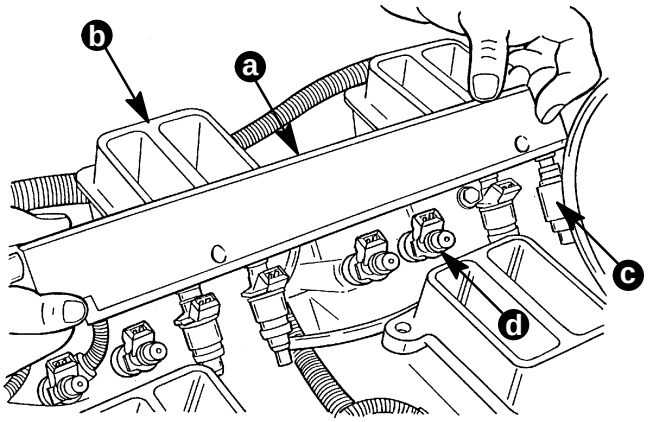
72915

a - Fuel Rail
b - Fuel Inlet Line
c - Fuel Outlet Line
d - O-Rings
e - Fuel Line Retainer
f - Screw
g - Fuel Rail Mounting Screws

4. Remove fuel rail mounting screws.
5. When facing front of engine, remove fuel rail as follows:

NOTE: *The left bank fuel injectors are to remain fully seated in the fuel rail throughout removal, while the right bank fuel injectors are to remain fully seated in the intake manifold throughout removal.*

   a. Working from front of engine to rear, slide the first front right bank fuel injector from the fuel rail. Next, slide the first front left bank fuel injector from the intake manifold. Continue sliding fuel injectors from their respective bores working back and forth toward rear of engine until fuel rail is free.



72798

a - Fuel Rail
b - Intake Manifold
c - Front Right Bank Fuel Injector
d - Front Left Bank Fuel Injector

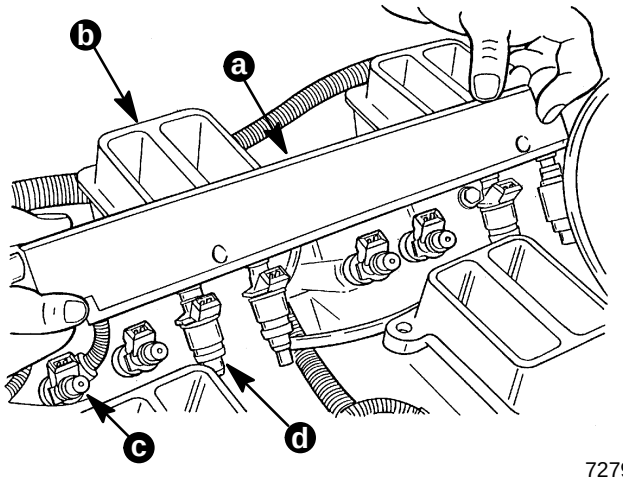
CLEANING AND INSPECTION

Inspect fuel injector seating area in fuel rail for pitting, nicks, burrs or irregularities, use a magnifying glass if necessary. If any of the above is present, replace the fuel rail.

INSTALLATION

NOTE: *Before installing fuel injectors, lubricate new fuel injector O-rings using a water/soap solution.*

1. When standing at front of engine, install fuel rail as follows:
   a. Install four left bank fuel injectors into left bank of fuel rail.
   b. Install four right bank fuel injectors into right bank of intake manifold.
   c. Working from rear of engine to front, insert the first rear left bank fuel injector into the intake manifold. Next, insert the first rear right bank fuel injector into the fuel rail. Continue inserting fuel injectors into their respective bores working back and forth toward front of engine until all fuel injectors are in place.

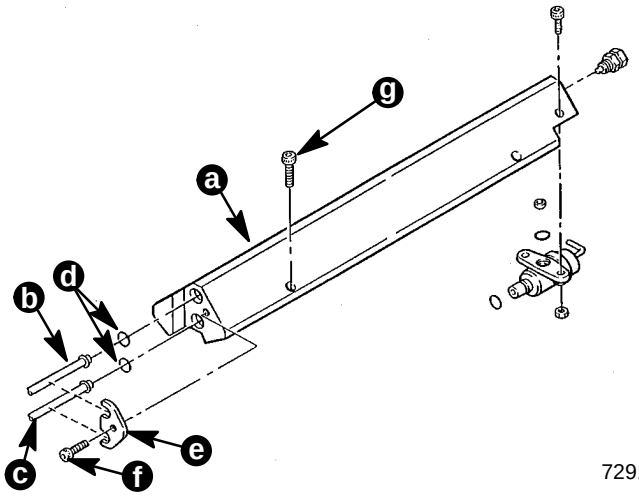


72798

a - Fuel Rail
b - Intake Manifold
c - Rear Right Bank Fuel Injector
d - Rear Left Bank Fuel Injector

2. Install fuel rail mounting bolts and torque to 105 lb. in. (12 N·m).

3. Install new O-rings on fuel inlet and outlet lines. Lubricate O-rings using a water soap solution and install lines to fuel rail. Secure fuel line retainer to fuel rail using screw.



72915

a - Fuel Rail
b - Fuel Inlet Line
c - Fuel Outlet
d - O-Rings
e - Fuel Line Retainer
f - Screw
g - Fuel Rail Retaining Screws

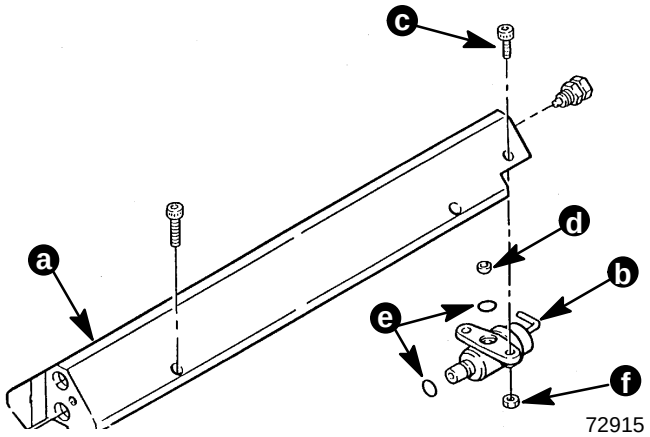
4. Connect electrical connector at each fuel injector.
5. Install plenum, throttle body and flame arrestor as outlined in this section.

Pressure Regulator

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Remove flame arrestor, throttle body, plenum and fuel rail as outlined in this section.
2. Remove pressure regulator attaching screws and nuts, and remove pressure regulator.



72915

a - Fuel Rail
b - Pressure Regulator
c - Screw
d - Filter
e - O-Rings
f - Nut

3. Carefully remove filter from fuel rail using an awl or equivalent tool.

CLEANING AND INSPECTION

1. Inspect pressure regulator seating area on fuel rail for pitting, nicks, burrs or irregularities. Use a magnifying glass if necessary. If any of the above is present, replace the fuel rail.
2. Clean filter of any debris using solvent. Dry using compressed air.

INSTALLATION

1. Install filter into appropriate bore of fuel rail.
2. Install new pressure regulator O-rings using a water and soap solution.
3. Carefully slide pressure regulator into fuel rail.
4. Apply Loctite 8831 to threads of attaching screws. Install screws and nuts and torque to 88-124 lb. in. (10-14 N·m).
5. Install fuel rail, plenum, throttle body and flame arrestor as outlined in this section.
6. With engine OFF, cycle ignition switch to ON wait 2 seconds, and then OFF, four times waiting 10 seconds after each key off to prime the fuel system and check for leaks.

Fuel Injectors

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

NOTE: *Use care in removing fuel injectors to prevent damage to the electrical connector and nozzle.*

IMPORTANT: The fuel injector is an electrical component. DO NOT soak in any liquid cleaner or solvent, as damage may result.

1. Remove flame arrestor, throttle body, plenum and fuel rail as outlined in this section.
2. Remove fuel injectors from fuel rail and intake manifold.

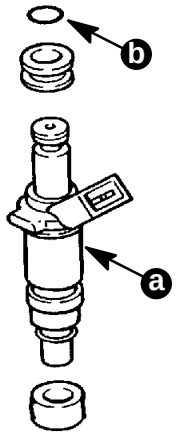
CLEANING AND INSPECTION

Inspect fuel injectors for damage; replace if necessary.

INSTALLATION

IMPORTANT: When replacing injectors, be certain to replace with the identical part and part number. Other injectors may have the same appearance, yet have a different part number and be calibrated for a different flow rate, and if installed, would cause performance difficulty or damage to the ECM.

1. Install new O-rings on fuel injectors. Lubricate O-rings using a water soap solution.



72799

a - Fuel Injector
b - O-Ring

2. Install fuel injectors as outlined in "Fuel Rail" and "Intake Manifold."
3. Install fuel rail, plenum, throttle body and flame arrestor as outlined in this section.

Throttle Body Injection and Multi-Port Injection Sensor and Module Servicing

Precautions

⚠WARNING

BEFORE attempting to disconnect and remove any module or sensor, check to make sure that the engine ignition system is OFF. Then disconnect the negative (–) battery cable from the terminal. DO NOT reconnect the negative (–) battery cable until the module or sensor removed has been re-installed with secure connections.

IMPORTANT: Modules and sensors are electrical devices easily damaged by contact with liquid cleaners or solvents. Clean with a dry cloth unless specifically directed to do otherwise.

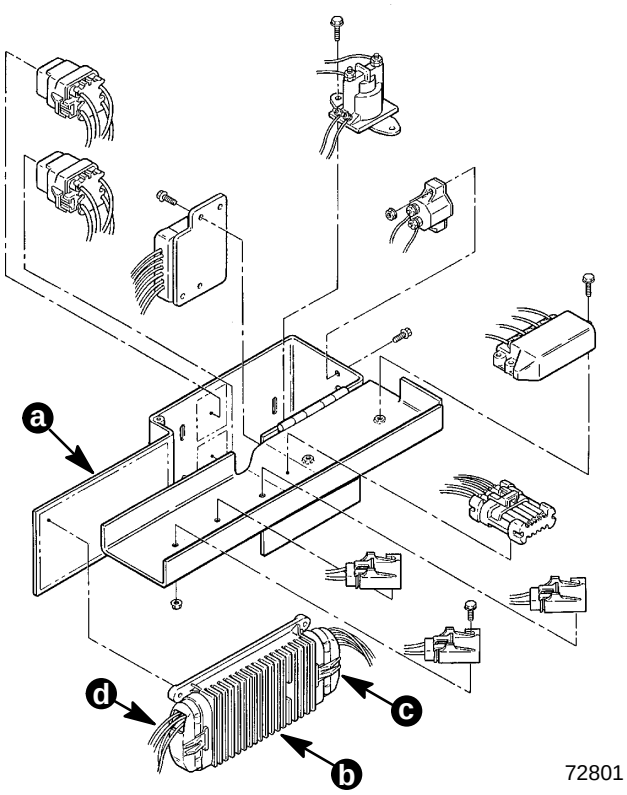
Electronic Control Module (ECM)

IMPORTANT: The ECM is a sensitive electrical device, subject to electrostatic damage. Therefore, take care not to touch connector pins when removing or installing the module.

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Disconnect J1 and J2 electrical connectors at engine control module (ECM).



72801

a - Electrical Bracket
b - ECM
c - J1- Electrical Connector (Front Connector)
d - J2- Electrical Connector (Rear Connector)

2. Remove ECM from electrical bracket.

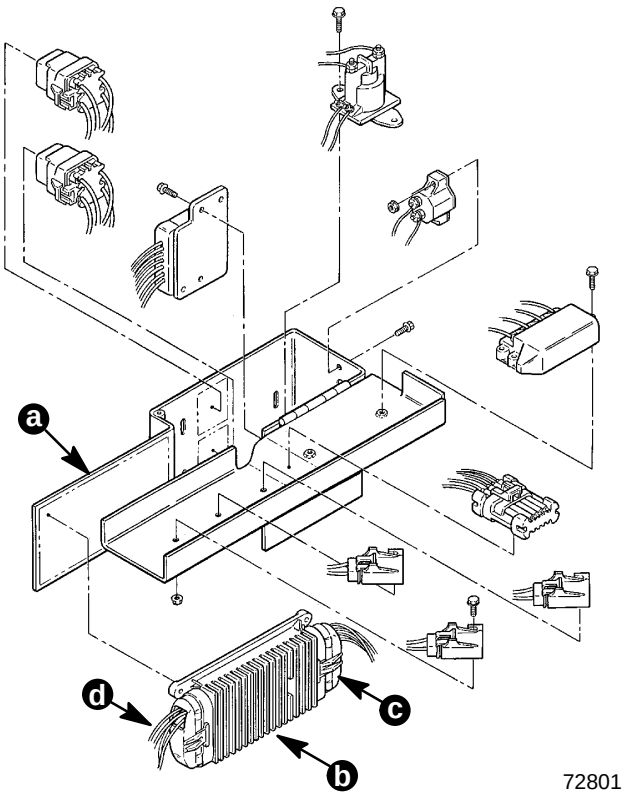
CLEANING AND INSPECTION

1. Clean the exterior of the ECM with a dry cloth being careful to avoid contact with connector pins.
2. Inspect outer surfaces for any obvious damage
3. Visually inspect electrical pins at both ends of ECM for straightness and corrosion.
4. Visually inspect J1 and J2 connectors on the wiring harness for corrosion and terminals that may have backed of the harness.

NOTE: *The ECM is a sealed electrical component. If a Code 51 check has shown it to be defective, replace the unit with another ECM having the same part number and service number as the original.*

INSTALLATION

1. Mount new ECM to electrical bracket.
2. Connect J1 and J2 electrical connectors to the ECM.



72801

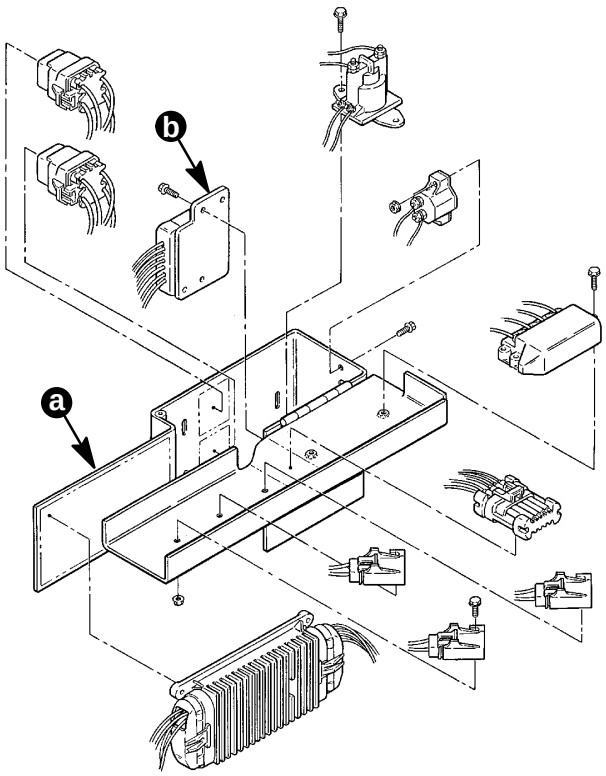
a - Electrical Bracket
b - ECM
c - J1- Electrical Connector (Front Connector)
d - J2- Electrical Connector (Rear Connector)

Knock Sensor (KS) Module

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Remove Knock Sensor from electrical bracket.



72801

a - Electrical Bracket
b - Knock Sensor (KS) Sensor

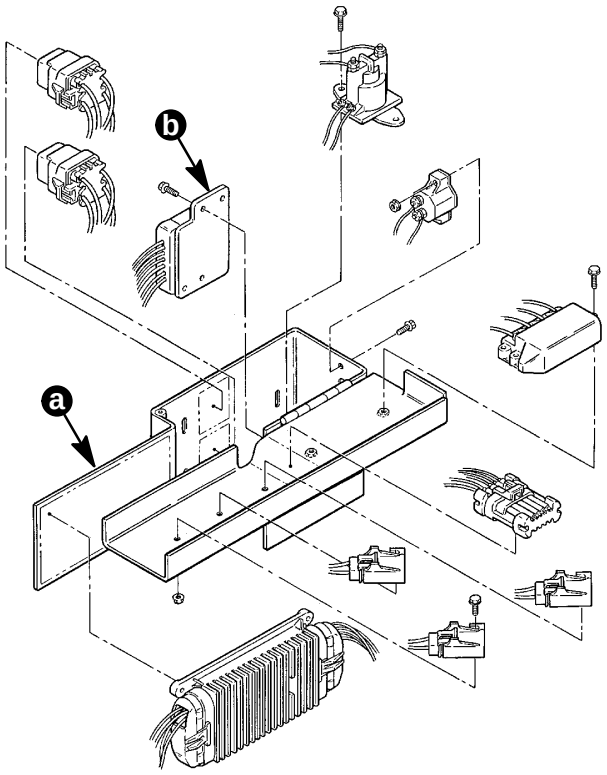
2. Disconnect electrical connector at Knock Sensor (KS) module.

CLEANING AND INSPECTION

1. Clean the external surfaces of the KS module with a dry cloth.
2. Inspect surfaces of KS module for evidence of damage.

INSTALLATION

1. Connect electrical connector to the Knock Sensor (KS) module.
2. Mount KS module to electrical bracket.



72801

a - Electrical Bracket
b - Knock Sensor (KS) Sensor

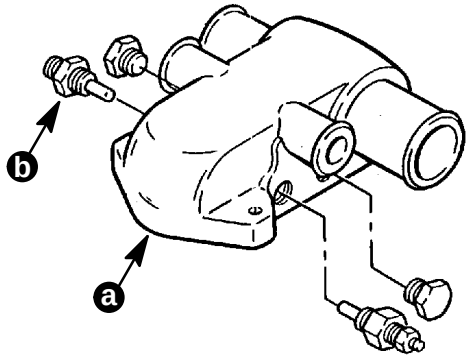
Engine Coolant Temperature (ECT) Sensor

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

NOTE: *Handle the ECT carefully as any damage to it will affect operation of the system.*

1. Disconnect electrical connector at Engine Coolant Temperature (ECT) sensor.



72799

a - Thermostat Housing
b - Engine Coolant Temperature (ECT) Sensor

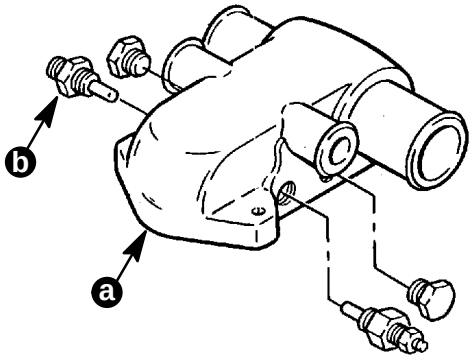
2. Remove ECT from thermostat housing.

CLEANING AND INSPECTION

1. Clean with a dry cloth, removing any excess sealant from the base threads.
2. Look for evidence of any physical damage to base or connector surfaces of the ECT.

INSTALLATION

1. Install ECT in thermostat housing. TIGHTEN HAND TIGHT PLUS 2-1/2 TURNS MAXIMUM.



72799

a - Thermostat Housing
b - Engine Coolant Temperature (ECT) Sensor

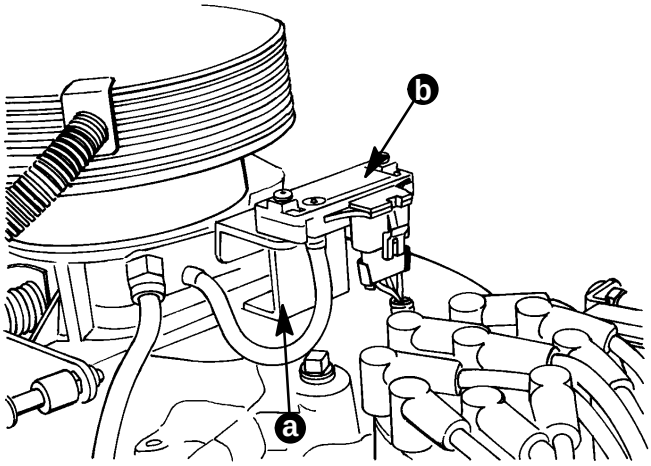
2. Connect electrical connector to ECT.

Throttle Body Injection Components-Manifold Absolute Pressure (MAP) Sensor

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Disconnect electrical connector at manifold absolute pressure (MAP) sensor.



74939

a - Throttle Body Adapter Plate
b - Manifold Absolute Pressure (MAP) Sensor

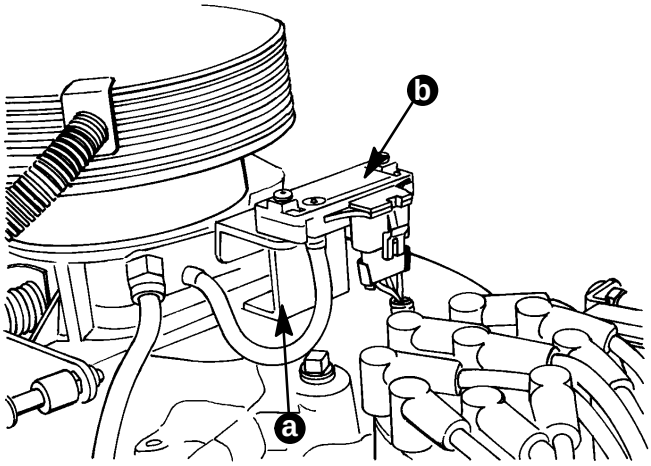
2. Remove MAP sensor from throttle body adapter.

CLEANING AND INSPECTION

1. Clean off any foreign matter with a dry cloth.
2. Inspect for any obvious signs of physical damage to the sensor.

INSTALLATION

1. Install MAP sensor to throttle body adapter using screws. Torque screws to 44-62 lb. in. (5-7 N·m).
2. Connect electrical connector to MAP sensor.



74939

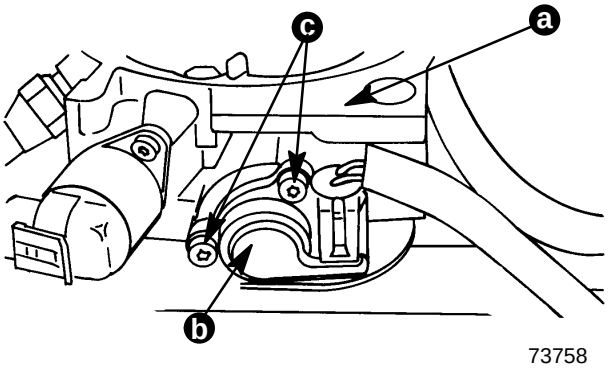
a - Throttle Body Adapter Plate
b - Manifold Absolute Pressure (MAP) Sensor

Throttle Position (TP) Sensor

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Disconnect electrical connector at throttle position (TP) sensor.
2. Remove TP sensor from throttle body.



73758

a - Throttle Body
b - Throttle Position (TP) Sensor
c - Screws

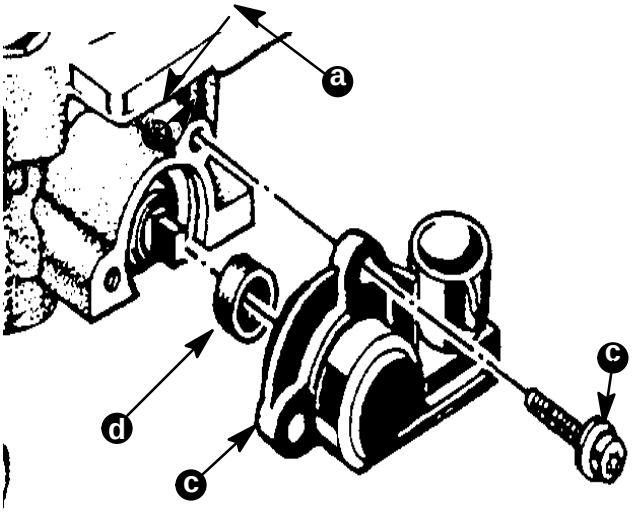
CLEANING AND INSPECTION

1. Clean the surfaces of the TP sensor with a dry cloth.
2. Inspect the TP sensor for signs of wear or damage.

INSTALLATION

IMPORTANT: If the TP sensor is to be replaced with a new unit, be sure to secure it in place with the new screws which are included in the service package.

1. Install TP sensor to throttle body using screws with washers and Loctite 242 applied to threads. Torque screws to 20 lb. in (2 N·m).



73758

a - Throttle Body
b - Throttle Position (TP) Sensor
c - Screws With Lockwashers
d - Seal

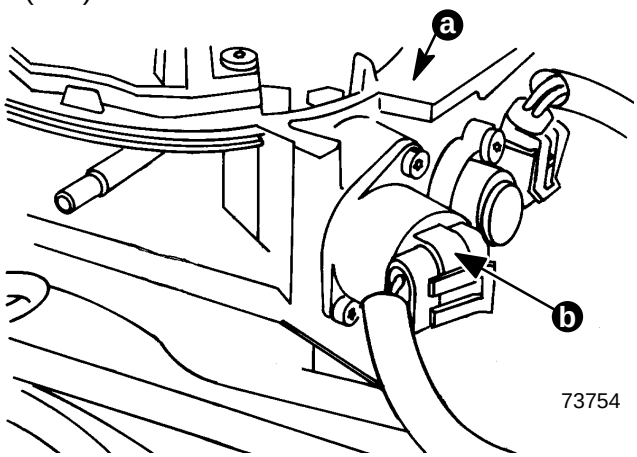
2. Connect electrical connector to TP sensor.
3. Install throttle body, throttle linkage and flame arrestor as outlined in “Throttle Body.”
4. Start engine and check for TP sensor output voltage. It should be approximately .7V at idle and 4.5V at W.O.T.

Idle Air Control (IAC) Valve

NOTICE
Refer to “Service Precautions,” in “Repair Procedures,” BEFORE proceeding.

REMOVAL

1. Remove flame arrestor, throttle cable and throttle body as outlined in “Throttle Body.”
2. Disconnect electrical connector at idle air control (IAC) valve.



73754

a - Throttle Body
b - Idle Air Control (IAC) Valve

3. Remove IAC from throttle body.

CLEANING AND INSPECTION

1. Remove and discard sealing O-ring from IAC valve. Clean sealing surfaces, pintle valve seat, and air passage with a carburetor cleaner to remove carbon deposits, being careful not to push or pull on the IAC valve pintle. Force exerted on the pintle might damage the worm drive. DO NOT use a cleaner that contains the extremely strong solvent methyl ethyl ketone.

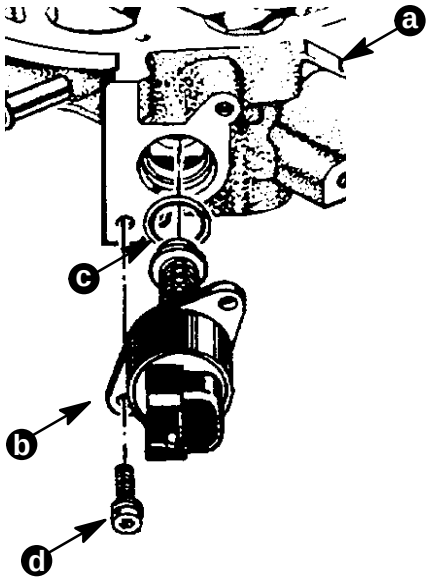
NOTE: *Shiny spots on the pintle, or seat, are normal and do not indicate misalignment or a bent pintle shaft.*

2. Inspect the entire assembly for any obvious physical damage.

INSTALLATION

IMPORTANT: If installing a new IAC valve, be sure to replace it with the correct IAC valve pintle shape and diameter are designed for the specific application.

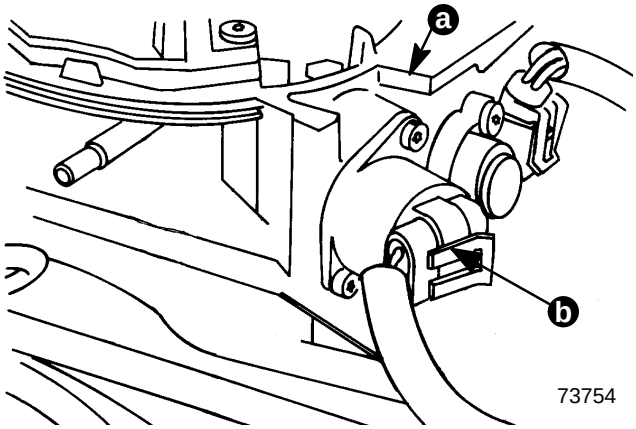
1. Install new O-ring on IAC valve.



73766

a - Throttle Body
b - Idle Air Control (IAC) Valve
c - O-Ring
d - Screws

2. Install IAC valve in throttle body using screws. Torque to 20 lb. in. (2 N·m).
3. Connect electrical connector to IAC valve.



73754

a - Throttle Body
b - Idle Air Control (IAC) Valve

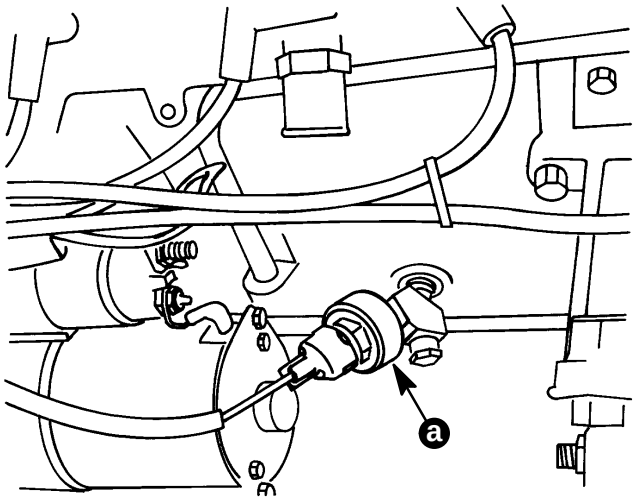
4. Reset IAC valve pintle position after reconnecting negative (–) battery cable.
   a. Turn ignition key ON for ten seconds.
   b. Turn ignition key OFF for ten seconds.
   c. Restart engine and check for proper idle operation.

Knock Sensor

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Disconnect electrical connector at knock sensor located just ahead of starter motor.



73757

a - Knock Sensor

2. Remove knock sensor from engine block.

CLEANING AND INSPECTION

1. Clean knock sensor with a dry cloth, paying special attention to threads on base.
2. Inspect surfaces of knock sensor for signs of wear or physical damage.

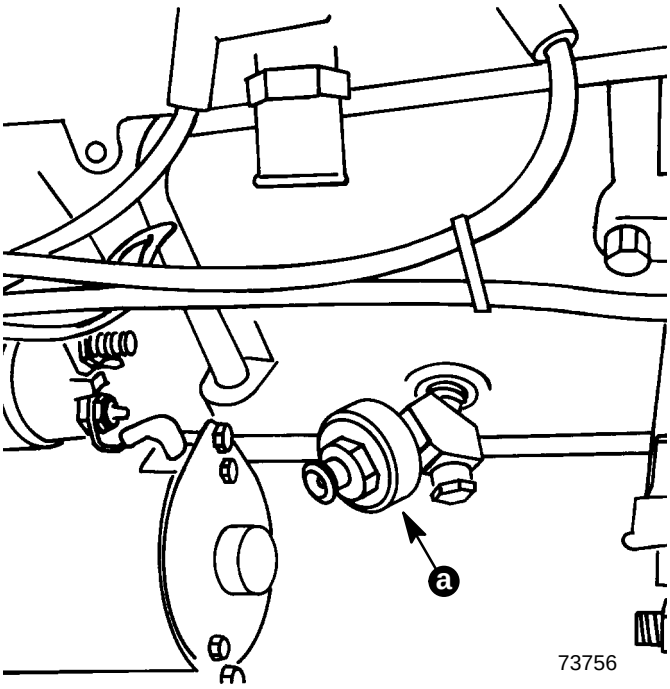
INSTALLATION

IMPORTANT: If installing a new knock sensor, be sure to replace it with an identical part. Knock sensors are very sensitive and designed for each specific application.

IMPORTANT: In the following step, it is very important that the knock sensor be torqued to the precise specification. Incorrect torquing will result in unsatisfactory performance. DO NOT use sealer on threads.

IMPORTANT: Ensure that the knock sensor is installed in the upper location on the Y-fitting.

1. Install knock sensor in engine block. Torque to 12-16 lb. ft. (16.3-21.7 N·m).



a - Knock Sensor

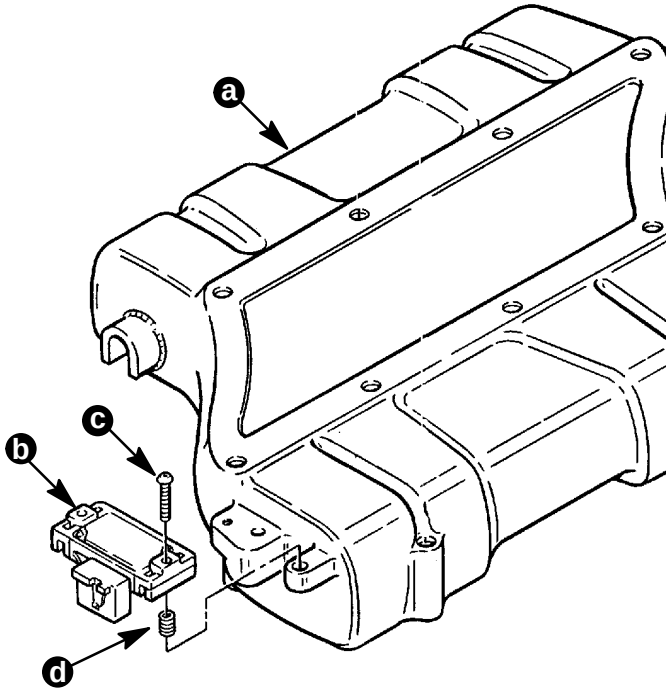
2. Connect electrical connector to knock sensor.

Multi-Port Injection Components- Manifold Absolute Pressure (MAP) Sensor

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Disconnect electrical connector at manifold absolute pressure (MAP) sensor.



72802

a - Plenum
b - Manifold Absolute Pressure (MAP) Sensor
c - Screws
d - Seal

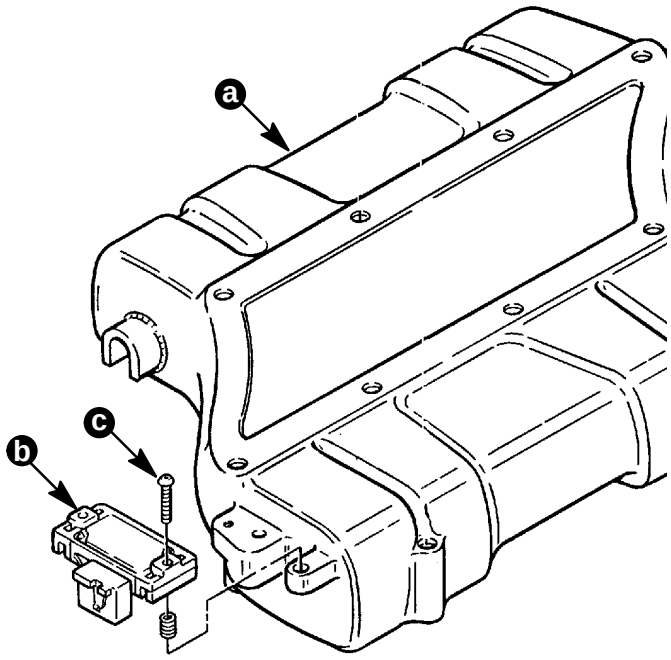
2. Remove screws from MAP sensor.
3. Remove MAP sensor from plenum.

CLEANING AND INSPECTION

1. Clean off any foreign matter with a dry cloth.
2. Inspect for any obvious signs of physical damage to the sensor.
3. Inspect seal for damage.

INSTALLATION

1. Install MAP sensor to plenum using screws. Torque screws to 44-62 lb. in. (5-7 N·m).



72802

a - Plenum
b - Manifold Absolute Pressure (MAP) Sensor
c - Screws

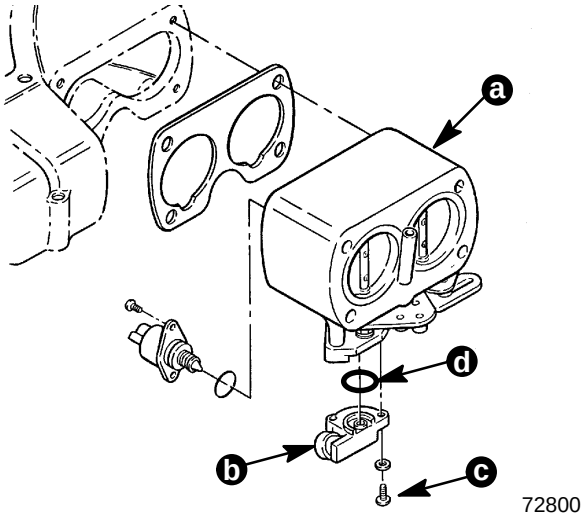
2. Connect electrical connector to MAP sensor.

Throttle Position (TP) Sensor

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Remove flame arrestor, throttle cable and throttle body as outlined in "Throttle Body."



a - Throttle Body
b - Throttle Position (TP) Sensor
c - Screws With Lockwashers
d - O-Ring

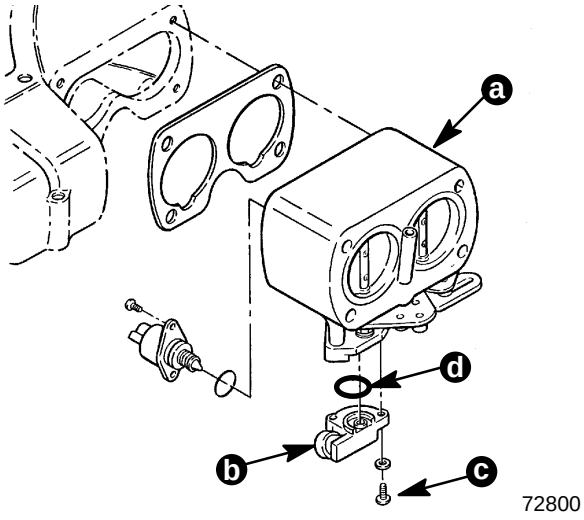
2. Remove TP from throttle body.

CLEANING AND INSPECTION

1. Clean the surfaces of the TP with a dry cloth.
2. Inspect the TP for signs of wear or damage.

INSTALLATION

1. Install TP sensor to throttle body using screws with washers and Loctite 242 applied to threads. Torque screws to 20 lb. in (2 N·m).



a - Throttle Body
b - Throttle Position (TP) Sensor
c - Screws With Lockwashers
d - O-Ring

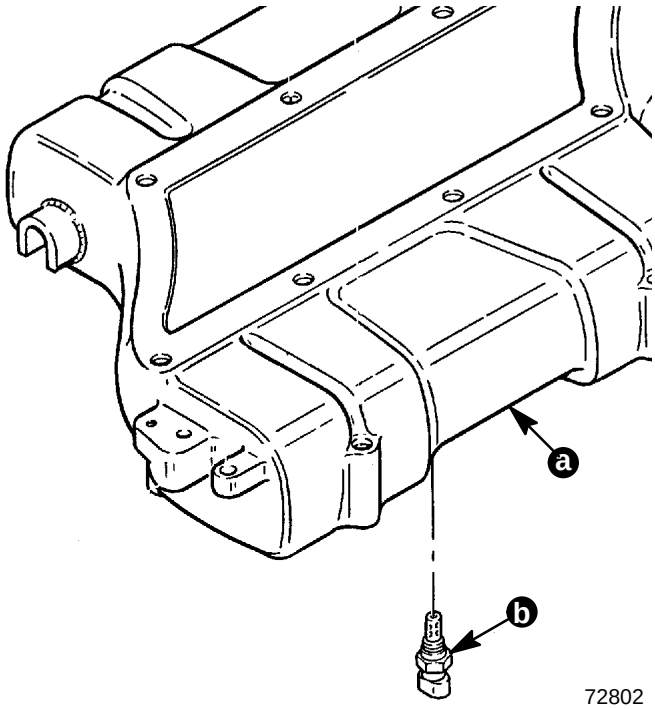
2. Install throttle body, throttle cable and flame arrestor as outlined in "Throttle Body."
3. When negative (–) battery cable has been reconnected, start engine and check for TP sensor output voltage. It should be approximately .7 V at idle and 4.5 V at W.O.T.

Intake Air Temperature (IAT) Sensor

NOTICE
Refer to “Service Precautions,” in “Repair Procedures,” BEFORE proceeding.

REMOVAL

1. Remove flame arrestor, throttle linkage, throttle body and plenum as outlined in “Plenum.”
2. Remove IAT from plenum.



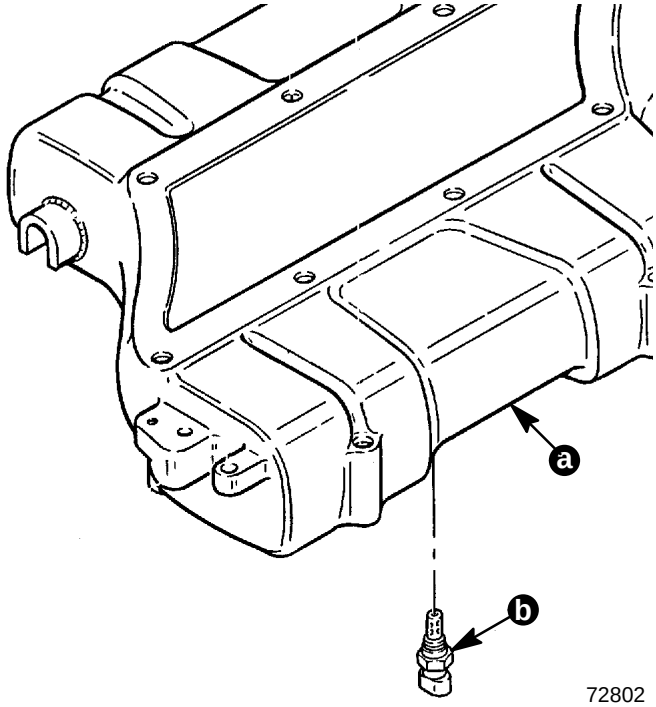
a - Plenum
b - Intake Air Temperature (IAT) Sensor

CLEANING AND INSPECTION

1. Clean the surfaces of the IAT with a dry cloth.
2. Inspect the IAT for signs of wear or damage.

INSTALLATION

1. Install IAT in plenum. Tighten 2-1/2 turns maximum.



a - Plenum
b - Intake Air Temperature (IAT) Sensor

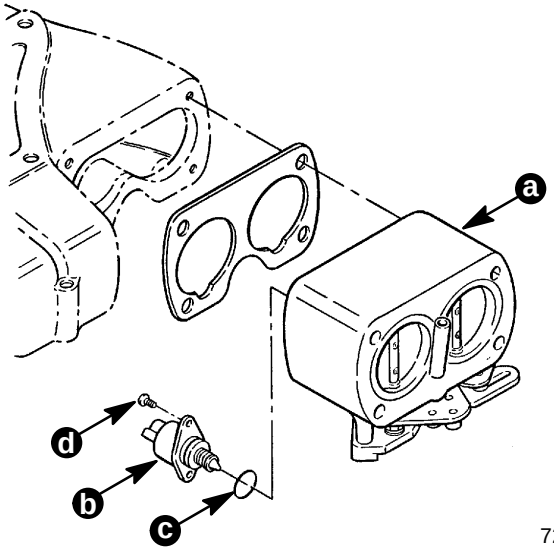
2. Install plenum, throttle body, throttle cable and flame arrestor as outlined in “Plenum.”
3. Connect electrical connector to IAT.

Idle Air Control (IAC) Valve

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Remove flame arrestor, throttle cable and throttle body as outlined in "Throttle Body."
2. Disconnect electrical connector at idle air control (IAC) valve.



72800

a - Throttle Body
b - Idle Air Control (IAC) Valve
c - O-Ring
d - Screws

3. Remove IAC from throttle body.

CLEANING AND INSPECTION

1. Remove and discard sealing O-ring from IAC valve. Clean sealing surfaces, pintle valve seat, and air passage with a carburetor cleaner to remove carbon deposits, being careful not to push or pull on the IAC valve pintle. Force exerted on the pintle might damage the worm drive. DO NOT use a cleaner that contains the extremely strong solvent methyl ethyl ketone.

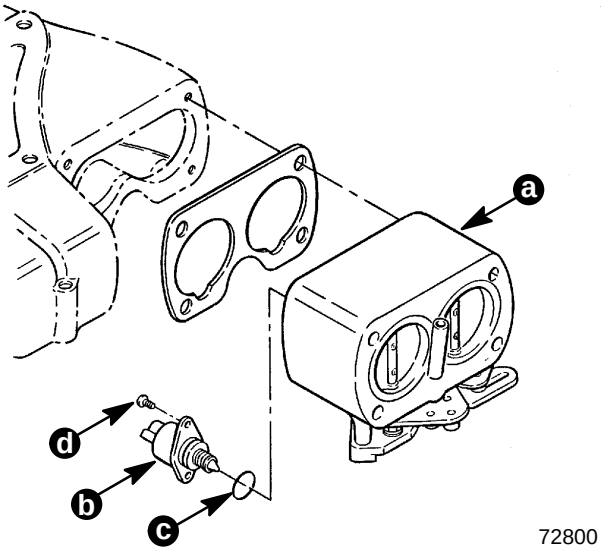
NOTE: *Shiny spots on the pintle, or seat, are normal and do not indicate misalignment or a bent pintle shaft.*

2. Inspect the entire assembly for any obvious physical damage.

INSTALLATION

IMPORTANT: If installing a new IAC valve, be sure to replace it with an identical part. IAC valve pintle shape and diameter are designed for the specific application.

1. Install new O-ring on IAC valve.



72800

a - Throttle Body
b - Idle Air Control (IAC) Valve
c - O-Ring
d - Screws

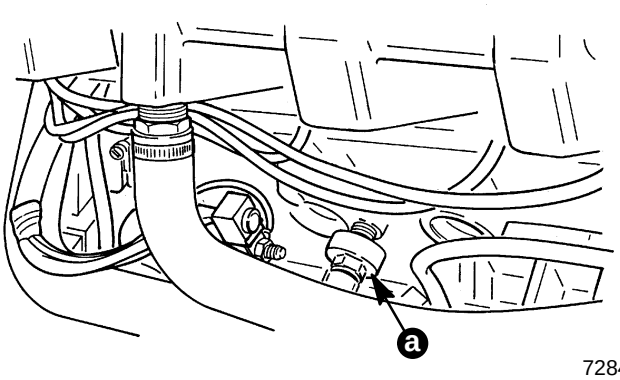
2. Install IAC valve in throttle body using screws. Torque to 20 lb. in. (2 N·m).
3. Install throttle body, throttle linkage and flame arrestor as outlined in " Throttle Body."
4. Reset IAC valve pintle position.
   a. Turn ignition key ON for ten seconds.
   b. Turn ignition key OFF for ten seconds.
   c. Restart engine and check for proper idle operation.

Knock Sensor

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Disconnect electrical connector at knock sensor located just ahead of starter motor.



72846

a - Knock Sensor

2. Remove knock sensor from engine block.

CLEANING AND INSPECTION

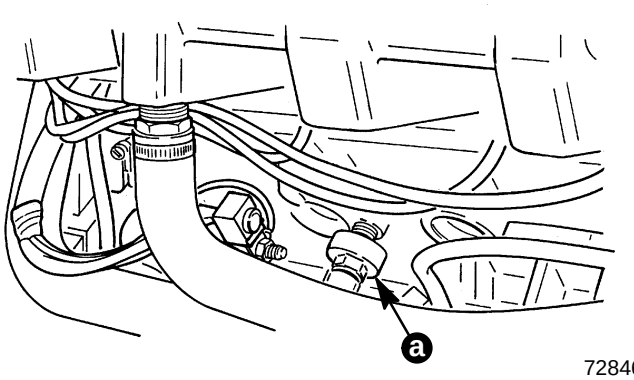
1. Clean knock sensor with a dry cloth, paying special attention to threads on base.
2. Inspect surfaces of knock sensor for signs of wear or physical damage.

INSTALLATION

IMPORTANT: If installing a new knock sensor, be sure to replace it with an identical part. Knock sensors are very sensitive and designed for each specific application.

IMPORTANT: In the following step, it is very important that the knock sensor be torqued to the precise specification. Incorrect torquing will result in unsatisfactory performance. DO NOT use sealer on threads.

1. Install knock sensor in engine block. Torque to 12-16 lb. ft. (16.3-21.7 N·m).



72846

a - Knock Sensor

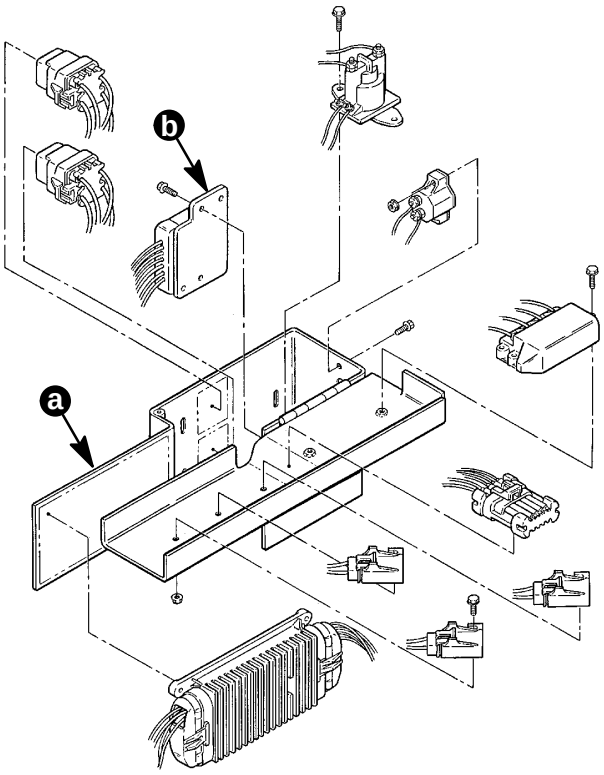
2. Connect electrical connector to knock sensor.

Knock Sensor (KS) Module

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Remove KS module from electrical bracket.



72801

a - Electrical Bracket
b - Knock Sensor Module

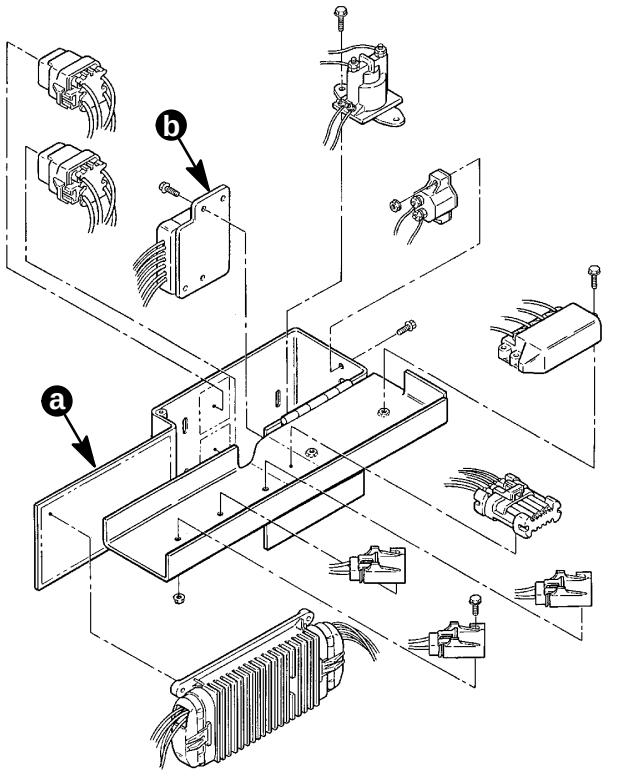
2. Disconnect electrical connector at Knock Sensor (KS) module.

CLEANING AND INSPECTION

1. Clean the external surfaces of the KS module with a dry cloth.
2. Inspect surfaces of KS module for evidence of damage.

INSTALLATION

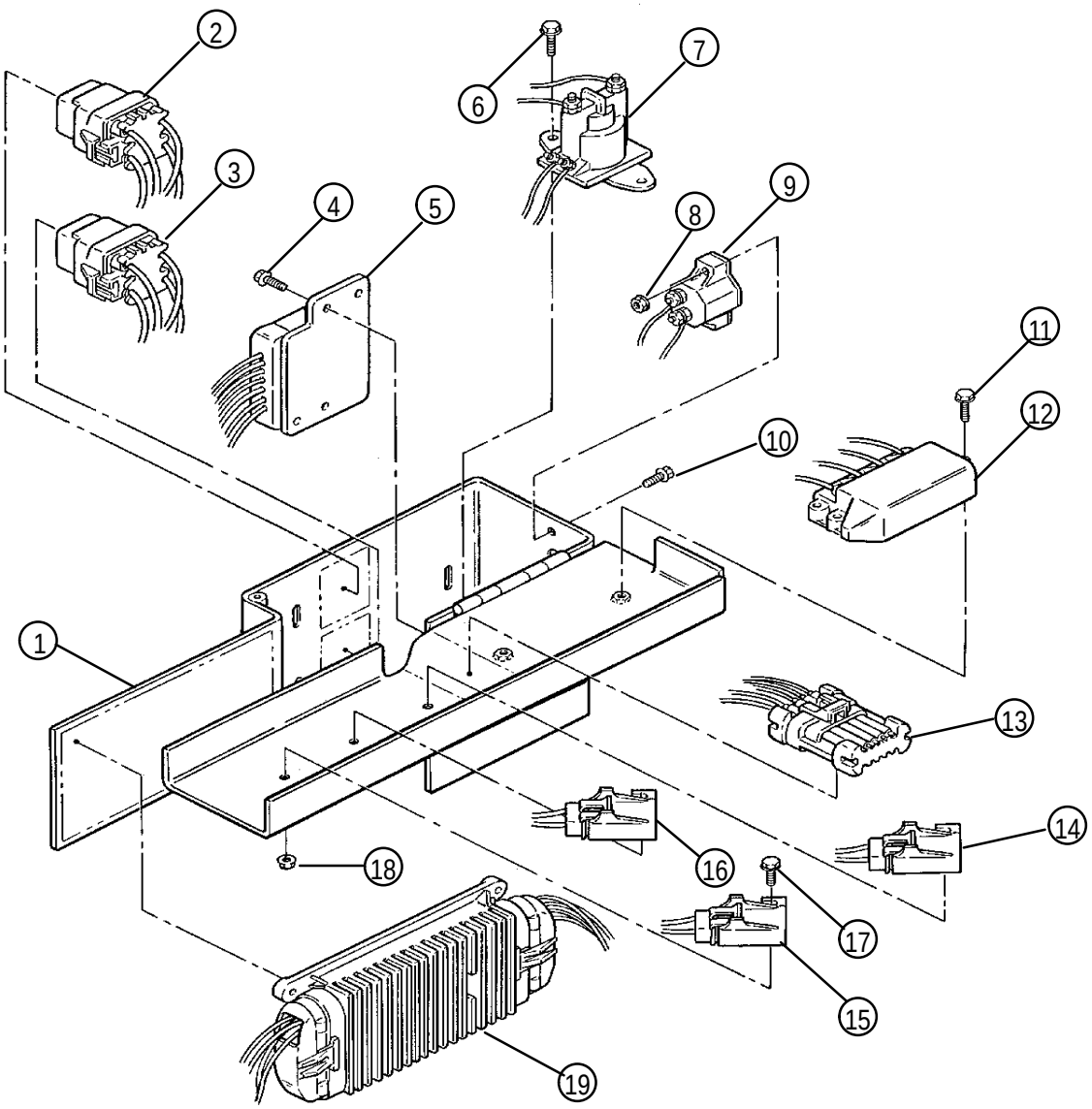
1. Mount KS module to electrical bracket.
2. Connect electrical connector to the KS module.



72801

a - Electrical Bracket
b - Knock Sensor Module

ELECTRICAL BOX (TYPICAL)



72801

1 - Bracket
2 - Relay
3 - Relay
4 - Screw
5 - Knock Sensor (KS) Sensor
6 - Screw
7 - Slave Solenoid
8 - Nut
9 - Circuit Breaker
10- Screw
11- Screw
12- MerCathode
13- Data Link Connector (DLC)
14- Circuit Breaker Fuse
15- Circuit Breaker Fuse
16- Circuit Breaker Fuse
17- Screw
18- Nut
19- Engine Control Module (ECM)

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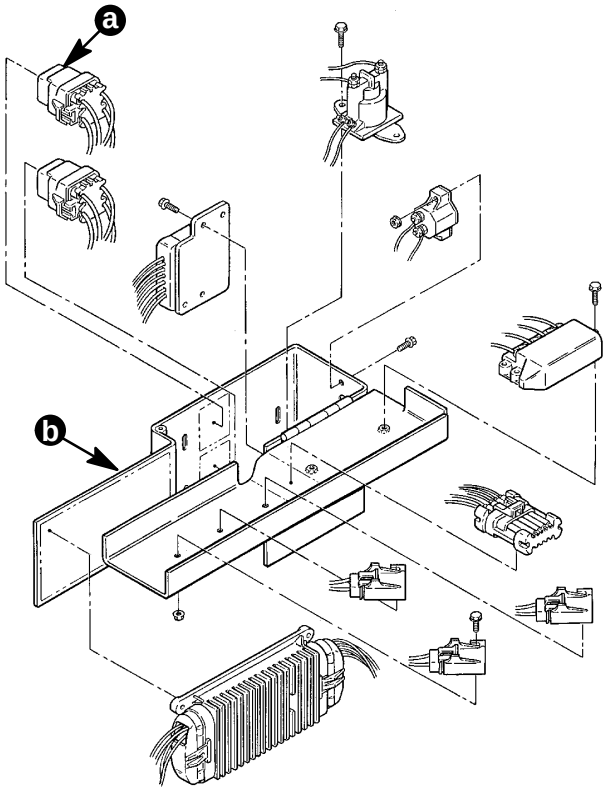
Fuel Pump Relay

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Detach fuel pump relay from bracket.



72801

a - Fuel Pump Relay
b - Bracket

2. Disconnect electrical connector and remove fuel pump relay.

IMPORTANT: The fuel pump relay is an electrical component. DO NOT soak in any liquid cleaner or solvent; damage may result.

INSTALLATION

1. Insert electrical connector into fuel pump relay.
2. Attach fuel pump relay to bracket.

Ignition Control (IC) System Components

Precautions

⚠WARNING

When performing the following procedures, be sure to observe the following precautions to avoid damage to equipment or personal injury:

DO NOT touch or disconnect any ignition system parts while the engine is running.

DO NOT reverse battery cable connections. System is negative (–) ground.

DO NOT disconnect battery cables while engine is running.

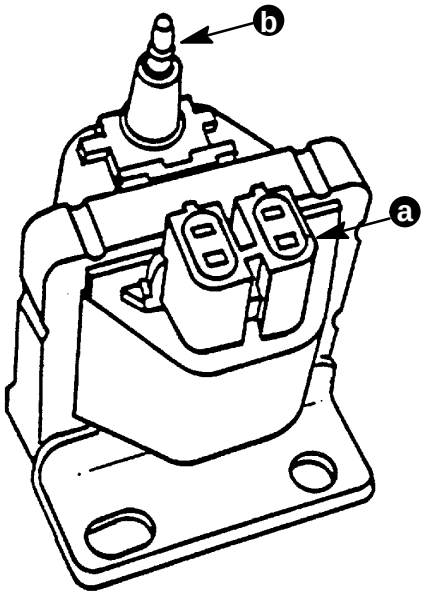
When it is necessary to move any of the wiring, whether to lift wires away from their harnesses or move harnesses to reach components, take care that all wiring is replaced in its original position and all harnesses are routed correctly. Electrical problems can result from wiring or harnesses becoming loose and moving from their original positions or from being re-routed.

Ignition Coil

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Disconnect wire harness connectors at coil.



72921

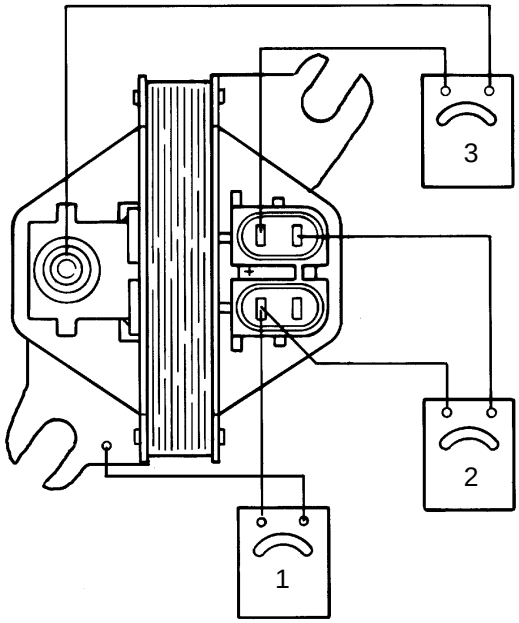
a - Wire Harness Connection
b - High Tension Coil Lead Connection

2. Remove high tension coil lead.
3. Remove coil bracket fasteners and remove coil bracket with coil.

RESISTANCE CHECK

Use an ohmmeter or the ohms function of a DVM for the following check.

1. Connect meter as shown with meter 1 in the figure below.



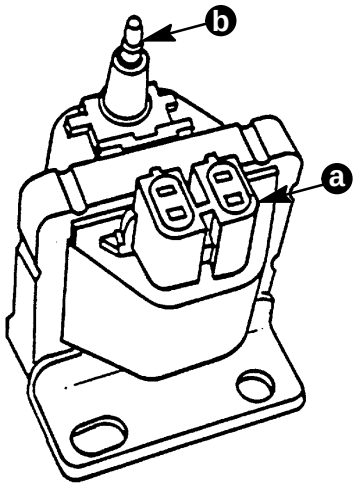
72920

2. Setting the meter to its highest ohms scale, check resistance. The reading should indicate infinite resistance. If it does not, replace the coil.
3. Connect meter as shown with meter 2 in the figure above.
4. Setting the meter to its lowest ohms scale, check resistance. The reading should be very low or zero resistance. If it is not, replace the coil.
5. Connect meter as shown with meter 3 in the figure above.
6. Setting the meter to its highest ohms scale, check resistance. The reading should not indicate infinite resistance. If it does, replace the coil.

INSTALLATION

7. Install coil bracket with coil to engine bracket using fasteners.

8. Connect high tension coil lead.



72921

a - Wire Harness Connection
b - High Tension Coil Lead Connection

9. Connect wire harness connectors.

IGNITION TIMING SET PROCEDURE

The engine must be at **NORMAL OPERATING TEMPERATURE** for this adjustment. Two items of test equipment are required: an inductive pickup timing light and either a Scan Tool, Diagnostic Code Tool, or MerCruiser Special Timing Tool (91-805747A1).

1. Connect timing light to number 1 ignition wire.
2. Connect the appropriate tool (as listed above) to the DLC connector of the wiring harness.
3. Manually adjust the engine throttle to **1800 RPM ± 200.**
4. **If Not Using MerCruiser Timing Tool:** With engine running, set the scan tool or Diagnostic Code Tool to service mode.
5. Shine the timing light at the timing mark indicator located on the timing chain cover.

NOTE: *If adjustment is needed, loosen the distributor hold-down bolt and rotate the distributor clockwise or counterclockwise to adjust the timing. Then repeat the timing light check until the specification (8 degrees BTDC) is met.*

6. Torque distributor hold-down bolt to 30 lb. ft. (40 N·m).
7. Set Scan Tool or Diagnostic Code Tool to normal mode. If using the MerCruiser Special Timing Tool, disconnect it from DLC connector.
8. Manually close throttle to bring engine down to idle state.

Spark Plug Replacement

SPARK PLUG WIRING AND BOOT PRECAUTIONS

1. **Twist boots one-half turn before removing.**
2. **When removing boot, DO NOT use pliers or other sharp tools which might tear the boot.**
3. **DO NOT force any object between the wire and the boot or through the silicone jacket of the wiring.**
4. **DO NOT pull on the wires to remove the boot. Pull on the boot or use a tool designed for this purpose.**
5. **Special care must be used when installing spark plug boots to ensure that the metal terminal within the boot is fully seated on the spark plug terminal and that the boot has not moved on the wire. If boot-to-wire movement has occurred, the boot will give a fast visual impression of being seated. To make sure that boots have been properly installed, push sideways on them. If they have been correctly installed, the boots will fit tightly with only a slight looseness. If the terminal has not been firmly seated on the spark plug, only the resistance of the rubber boot will be felt when pushed sideways.**

REMOVAL

1. Disconnect spark plug wires from spark plugs.
2. Remove spark plugs.

CLEANING AND INSPECTION

1. Clean spark plugs and spark plug wires with a dry cloth.
2. Check each spark plug for wear and gap width per MerCruiser specifications. Replace any which fail to meet the standards.
3. Check spark plug wires for damage to insulation, boots and connectors. Replace if necessary.

INSTALLATION

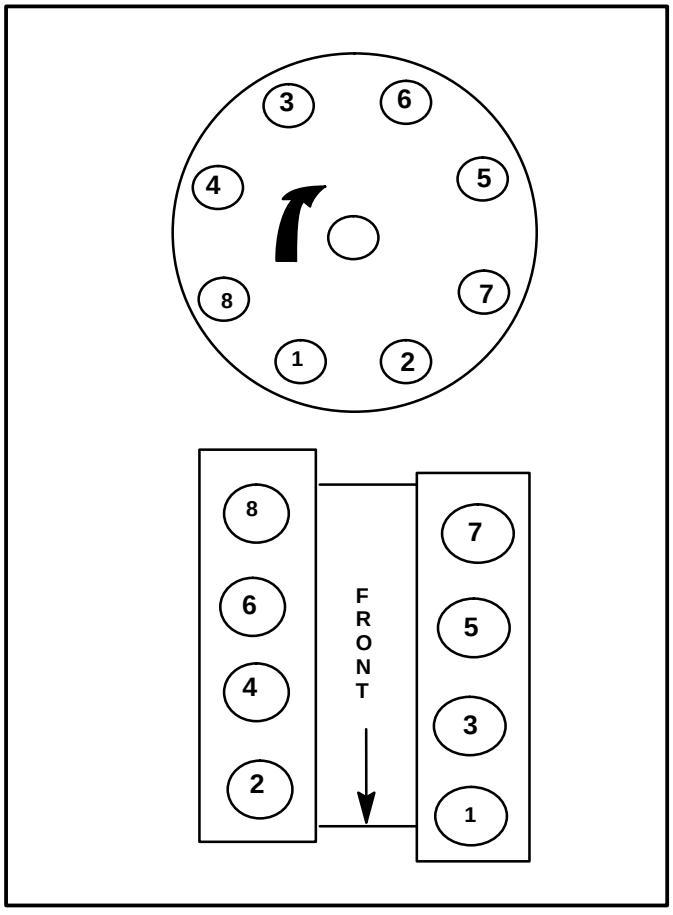
1. Install spark plugs. Torque to 11 lb. ft. (15 N·m).
2. Connect spark plug wires to their respective spark plug.

IMPORTANT: Wire routing must be kept intact during service and followed exactly when wires have been disconnected or when wire replacement is necessary. Failure to route wires properly can lead to radio frequency interference, cross firing of the plugs, and/or shorting of leads to ground.

NOTE: *When replacing spark plug wires, it is good practice to replace one wire at a time to reduce the risk of error.*

REMOVAL AND INSTALLATION

1. Disconnect one spark plug wire at spark plug and distributor.
2. Connect new spark plug wire at spark plug and distributor.
3. Continue steps 1 and 2 until all spark wires have been replaced.



Engine Rotation and Firing Order

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